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WONDERS

OF THE

NINETEENTH CENTURY

A PANORAMIC REVIEW

OF THE

INVENTIONS AND DISCOVERIES OF THE PAST HUNDRED YEARS

INCLUDING

DESCRIPTIONS AND PICTURES

OF THE IMPROVEMENTS IN AGRICULTURE, MEDICINE, CHEMISTRY, ARMS, ASTRONOMY, BIOLOGY, WEAVING, GAS, ELECTRICITY, GEOLOGY, IRON MANUFACTURE, STEAM NAVIGATION AND LOCOMOTION, PRINTING, PHOTOGRAPHY, ETC., ETC., AND

THE PROGRESS OF MANKIND

IN PEACE, PRISON REFORM, LITERATURE, ART, TEMPERANCE, AND ALL MODERN MOVEMENTS,

TOGETHER WITH INTERESTING STORIES

OF THE BICYCLE, INDIA RUBBER, FRICTION MATCH, GUN-COTTON, PERCUSSION CAP, REAPER AND MOWER, LIFEBOAT, BREECH-LOADER, RIFLE BARREL, LOCOMOTIVE, POWER PRESS, TELEPHONE, TELEGRAPH, TELESCOPE, MICROSCOPE, TYPEWRITER, REVOLVER, SPECTROSCOPE, SEWING MACHINE, ETC., ETC.

LAVISHLY ILLUSTRATED

WITH LINE AND PHOTO ENGRAVINGS OF THE CENTURY'S CELEBRITIES, AND THE THINGS WHICH HAVE CONTRIBUTED TO THE WORLD'S EVOLUTION AND DEVELOPMENT

BY J. W. HANSON, A. M., D. D.

CHICAGO
W. B. CONKEY COMPANY, PUBLISHERS
1900

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INTRODUCTION.

1800—1900.

IN our day progress makes leaps and jumps. There are multitudes living who can remember when there was no such thing as transportation by steam; now a line of railway or a train of cars is on almost every square mile of civilization. A half-century ago, even, electric communication was a chimera; now there are millions of miles of electric wires, and the uttermost parts of the earth are within talking distance of each other. Twenty years ago the telephone was a toy; now it is in almost universal use, and it seems as if it had always been in existence. Within fifty years it required a month to cross the ocean, and those who crossed were comparatively few; now we cross in a week, and those who cross annually are numbered by hundreds of thousands. A century ago most of the members of every family had to work at spinning and weaving to keep themselves and the rest in clothing; since then the speed of steam spindles has constantly increased, and steam looms have so improved in effectiveness that good clothing is no longer a luxury. The use of steam as a motive power was then in its infancy, and the methods of using this powerful agent have multiplied exceedingly. The speed of the passenger train has more than doubled in the last fifty years, and regular trains are now run at the rate of a mile a minute.

The first cars were lighted with candles and heated by cheap stoves; now one can travel from the Atlantic to the Pacific, and, while *en route*, enjoy the luxuries of vestibule trains, lighted by electricity and heated by steam, veritable palaces on wheels, with all the conveniences of modern hotels. A century ago the country lacked many other conveniences besides railroads and steamboats. The telegraph and telephone were unknown. Electric lighting is comparatively a new invention, but in those days gas and kerosene oil had not begun to be used. Lamps of any kind were almost unknown, and houses were usually lighted with tallow candles, although candles made from wax were used on special occasions. Poor people burned a wick in a little vessel containing grease, or lighted pitch upon the hearth. The streets of large towns were lighted with dim lanterns.

A century ago there were no envelopes, postage stamps, cable cars, elevated roads, horseless carriages, steel pens, gold pens, fountain pens, friction matches, sewing machines, writing machines, anthracite coal, heaters, blotting paper, rubber overshoes, bathrooms in private houses and hotels, postal orders, ice chests, cold storage, photographs and photographic engravings, tomatoes as esculents, grape fruit, canned meats, vegetables and fruit, sewage in cities, transatlantic steamers, railroads, electric telegraphs

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and submarine cables, telephones and phonographs, street railroads of any kind, electric lights heat and cars, copying presses, steam printing presses, expresses, bicycles, steam fire engines, illuminating gas, wringing and washing machines, and agricultural machinery. How was social and physical comfort found without these things?

General Washington died at Mount Vernon on the 14th of December, but the first intelligence reached Congress, in session in Philadelphia, on the 19th; five days, one hundred and forty miles! In 1800, by river and coach, to reach Washington from New York, three days' time was required; New York to Philadelphia, in summer fifteen hours, but in winter twenty-seven and one-half; to Boston, thirty-eight hours, returning, fifty-two hours. Of course the carriage of freight required much greater time.

More than one-fourth of a million persons are now engaged in the railway service in the United States. What a vast development of industry, with what vast results, has accrued in less than three score years and ten! No wonder the grandson sometimes addresses grandsire thus:

> Now I wonder, excuse my impertinent tongue,
> How you ever went anywhere when you were young;
> For you couldn't recline in a plush-covered chair
> And be rapidly carried with ease anywhere
> While the train hurried on over mountain and dale
> To the trumpet of steam and the drum of the rail;
> And you couldn't sit down on a trolley car seat
> And be jiggled and jerked through the length of the street;
> And the glorious wheel, like a bird on the wing—
> You had not even heard of the wonderful thing.
> So I often have wondered, and wished I could know,
> If you ever went anywhere, how did you go?

The wonderful facilities enjoyed in these last days of the Nineteenth Century are nearly all less than a hundred years old. One who has not carefully considered the subject will be astounded when he reflects how recently the comforts, the luxuries, indeed the necessities he enjoys, have been discovered or invented, and he will find himself constantly wondering how his predecessors of even a century ago managed to exist without the railway, the steamboat, the telegraph, the telephone, the photograph, the power press, the sewing machine, anaesthesia, friction matches, reapers and mowers, gas, rubber, postage stamps, vaccination, typewriters, and a hundred other things that now seem absolutely essential to a tolerable existence.

The reader of this volume who has never in thought transported himself back to the beginning of the Nineteenth Century will be amazed to perceive the absence of the luxuries, comforts, conveniences, and even necessities of the present time. He may have ever so strong a feeling that wonderful progress has been made in all the departments of life, but unless he has devoted great attention to the subject he can have no adequate concep-

tion of the absence, a hundred years ago, of the immense number of what he considers the absolute necessities of a comfortable human condition. Most readers have a feeling that life has been pretty much as now for a long time at least, when, as this volume shows, all but the barest existence has been produced within a hundred years.

This work contains the names of the prominent representative men and women who have enriched the Nineteenth Century in which they lived and wrought. Of course, in a single volume, thousands deserving mention must be omitted, but the most prominent are given of those who, in Literature, Statesmanship, Invention, Discovery, Medicine, Science, Art, Philosophy, War, etc., have won exalted positions: the Philanthropists, Discoverers, Inventors, Poets, Orators, Sculptors, Painters, Musical Composers, Reformers, Physicians, Astronomers, and those eminent in every field of effort; and connected with their names will be found sketches of the great improvements, and the steps of progress accomplished, during the century.

Inventions and improvements in Agriculture, Medicine, Chemistry, Arms, Astronomy, Biology, Weaving, Gas, Electricity, Geology, Iron Manufacture, Steam Navigation and Locomotion, Printing, Photography, etc., are described, and the story is told of the Bicycle, the Friction Match, Gun Cotton, India Rubber, the Percussion Cap, the Reaper and Mower, the Lifeboat, the Breechloader, the Rifled Barrel, the Locomotive, the Power Press, the Telephone, the Telegraph, the Telescope, the Microscope, the Typewriter, the Revolver, the Propeller, the Spectroscope; and the progress of mankind in Peace, Temperance, Human Freedom, Literature, Art, Education, Philanthropy, Prison Reform, and all the great modern movements is related: so that the book gives a bird's-eye view of the great workers of the Nineteenth Century, and of their wonderful achievements, and contributions to the evolution and progress of mankind.

The reader will not, of course, look for detailed and minute descriptions of the great discoveries and inventions of the century, nor for full biographies of those who have made the age what it was—for only an encyclopædia could contain that record, but he will find bird's-eye glances and brief references that will indicate the greatness of the century, and of those who have made it the "Century of all the Centuries."

The celebrated English scientist, Alfred Russell Wallace, in his recent work, "The Wonderful Century," affirms that the inventions and discoveries of all the past centuries do not equal those of the present century. In all preceding ages he names the Mariner's Compass, the Steam Engine, the Telescope, the Barometer, the Thermometer, Printing, Arabic Numerals, Alphabetical Writing, Modern Chemistry, Electric Science Founded, Gravitation Established, Kepler's Laws, the Differential Calculus, the Circulation of the Blood, Light Proved to have Finite Velocity, the Development of Geometry—fifteen in all—from which, singularly enough, Gunpowder

and Firearms are omitted. Against these he offsets twenty-four during this century alone: Railways, Steamships, Electric Telegraphs, the Telephone, Lucifer Matches, Gas Illumination, Electric Writing, Photography, the Phonograph, the Roentgen Ray, Spectrum Analysis, Anaesthetics, Antiseptic Surgery, Conservation of Energy, Molecular Theory of Gases, Velocity of Light Directly Measured, the Uses of Dust, Chemistry, Definite Proportions, Meteors and the Meteoric Theory, the Glacial Epoch, the Antiquity of Man, Evolution, Cell Theory, Germ Theory of Disease. The reader of this book will perceive that Wallace's list comprises but a fraction of the wonderful discoveries and inventions of the age. The Sewing Machine, the Typewriter, the Machine Typesetter, the Rotary Printing Press, the Reaper and Mower, Breech-loading Firearms, the Revolver, the Torpedo, Dynamite, the Percussion Lock, the Bicycle, Dentistry, Bessemer Steel, the Postoffice, Prison Reform, the Power Loom, and a thousand and one additions to human knowledge and power in almost every department of life, add immensely to the achievements described in Wallace's list, and contribute far more to human advancement than do some of those he mentions, and not one of them is a century old! But Wallace does not exaggerate in saying: "Not only is our century superior to any that have gone before it, but it may best be compared with the whole preceding historical period. It must therefore be held to constitute the beginning of a new era of human progress."

Most centuries have been characterizable by a single epithet, as the Age of Discovery, the Elizabethan age, but the Nineteenth has been the Iron Age, the Coal Age, the Age of Invention, the Scientific age, the Age of Steam, the Age of Electricity, the age in which the human mind has explored a thousand avenues whose existence was undreamed of a hundred years ago. Beyond all others it is the Age of Progress.

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PROEM.

"The good old times, the grand old times, the great old times! Those were the times for every sort of thing. The good old times; what times they were! They were the only times. It's no use talking about any other times, or discussing what the people are in these times. You don't call these, times, do you? I don't."

CHAPTER I.

BEFORE THE DAYS OF MATCHES AND STOVES.

FIRST MATCHES—FIRST LUCIFER—ISAAC HOLDEN—FLINT AND STEEL—THE TINDER BOX—TALLOW DIPS—FIREPLACES—NO COAL OR STOVES—COLD HOUSES AND COLDER CHURCHES—THE GOOD OLD TIMES A MYTH.

THE flint and steel that engendered a spark in the ancient tinder box, invented when and by whom no one knows, was a wonderful improvement on the older method of producing fire by rubbing two sticks together—practiced ever since fire was discovered, probably by Adam and Eve—but it was the only way in which a fire could be started a hundred years ago. If the householder had not properly "raked up" the coals over night, by covering them with ashes so as to preserve them, or should the traveler need fire, he was compelled to produce the spark on tinder with flint and steel, and light the brimstone match. Before such a thing as a friction match was heard of, the writer of these pages had seen the process scores of times.

Early in the century the rush-light was used by "common people," and candles only on extraordinary occasions. The rush was peeled of the outer skin, except a narrow line that kept the pith together, and the end was dipped in lard, and the rush was inserted in the end of a split stick, which was at the other end inserted in a block for a foot. It was a candle*stick*, literally, and the word was transmitted to the tin or brass receptacle that succeeded it. Many a scholar laboriously acquired his first lessons by this wretched help. It was a little better than the firelight.

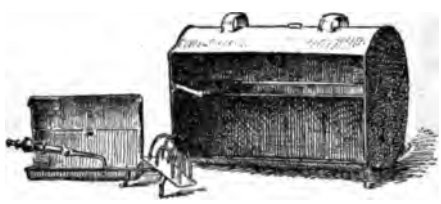
But the race was on the road to a great improvement. In 1669 Brandt had discovered phosphorus, and soon its properties were well studied and described. No use was at first made of it for procuring a light, but, in 1715, William Homburg made a pyrophorus, consisting of a mixture of alum and flour and sulphuric acid. In 1775 Volta made an electrophorus of resin, a plate of brass with an insulated handle, and a discharging knob attached to the rim. The resinous disk was rubbed with a piece of fur, and, on bringing the discharging knob near a conducting surface, a spark ignited the phosphorus. In 1805 Chancel, of Paris, introduced an apparatus consisting of a bottle containing asbestos, sulphuric acid, and matches coated with sulphur and tipped with chlorate of potash and sugar. The match was inserted in the bottle and was lighted by a chemical process. In 1816 Derosne produced a rude match tipped with phosphorus, which

ignited by friction. It was good in theory, but poor in practice. In 1832, a match was made by phosphorus and sulphur carefully mixed in a corked

SIR ISAAC HOLDEN.

glass tube. The wood was put into the tube, a portion of the mixture detached, and when brought into the air it ignited. Friction matches were made in 1827 by John Walker, an English druggist. They were called "congreves," thin strips of wood or cardboard coated with sulphur and tipped with a mixture of sulphide of antimony, chlorate of potash, and mucilage. Eighty-four of them were sold for twenty-five cents, with a piece of "glass paper," through which the match was drawn. In 1830, S. I. Jones, of London, invented "Prometheans," paper rolled tightly, containing chlorate of potash and sugar, and each roll had inside a small glass bubble filled with sulphuric acid. The bubble was bursted and light was produced.

But, in October, 1829, Isaac Holden (born 1807) invented the real Lucifer, and bestowed upon the world perhaps the greatest single domestic convenience of the century. He related the story of the discovery before the British House of Commons: "I began as an inventor on a very small scale. From what I know, I was the first inventor of Lucifer matches, but it was the result of a happy thought. In the morning I used to get up at four o'clock, in order to pursue my studies. I employed all that time the flint and steel, in the use of which I found great inconvenience. I gave lectures in chemistry at the time at a large academy. Of course I knew, as all other chemists did, the explosive material that was necessary in order to produce instantaneous light, but it was difficult to obtain a light on wood by that explosive material. The idea occurred to me to put under the explosive mixture sulphur. I did that and published it in my next lecture, and showed it. There was a young man in the room whose



STOVE, TOASTER AND TIN KITCHEN OF 1800.

father was a chemist in London, and he immediately wrote to his father about it. Shortly afterward Lucifer matches were issued to the world. I

believe that was the first occasion we had the present Lucifer match."

An independent fortune would have been the result had Holden been as shrewd as he was ingenious. He was born in Hurlet, a small village adjoining Nitshill, between Paisley and Glasgow, Scotland. His father had held a small farm. When Isaac was five years of age he engaged himself as a "draw-boy" to two weavers in the neighborhood. He continued to work as "draw-boy" for two years, during which time he went to a night school and diligently employed himself in improving his education. Later, he found employment in a cotton mill. When about thirteen years of age, he had the good fortune to become a pupil of John Fraser, an able and zealous teacher. His education went on in various ways, but meanwhile his father removed to Paisley, and Isaac was apprenticed to an uncle, a shawl weaver. But shawl weaving proved too much for his strength and he gave it up in a short time. At the age of twenty-one he became a teacher. Sir Isaac Holden was much more than the inventor of the modern Lucifer match. The story of how he rose from a collier's lad and a weaver's apprentice to a position of splendid commercial prosperity, and gained a degree of affluence which was great even in these days of princely fortunes, reads like a romance. As an example of what can be accomplished by integrity

CANDLE-DIPPING IN THE EARLY PART OF THE CENTURY.

of character, perseverance, inventive skill, and determined purpose, his career is one that may be studied with advantage. He invented and perfected the wool-combing machine as it is known and used to-day by the greatest firms of wool-combers in existence, and became a multi-millionaire and one of the world's great captains of industry. (See "Weaving.")

In 1833 matches were manufactured in England and Germany. Phosphorus was not much used at first on account of its dangerous character, but, in 1845, Von Schrötter, of Vienna, discovered red, or amorphous, phosphorus, which is perfectly safe. In 1855 Lundstrom, a Swede, using red phosphorus, invented the "safety" match, which lights only when struck on the box. Such improvements have been made, and machinery has so replaced hand labor, that matches may be bought by the hundred for the price of one seventy years ago. The John Jex Long machine turns out seventeen millions in a day, and the great establishments like the "Diamond" are important factors in the financial world.

Up to almost the middle of the century the flint and steel accompanied the traveler, and were essential to every household. What an advance has been made in the conveniences of life by this simple expedient, the friction match! Who, above forty, does not remember the clumsy sticks called sulphur matches, introduced about 1830, and sold at ten cents a hundred. Now the safety match costs one-tenth as much. All past middle life will remember the tray and snuffers which were found in every family, and have smiled at the dexterity with which the young men of the family could utilize thumb and finger in snuffing the candle. Up to 1800, candles were found in light-houses to guide the mariner at sea.

A hundred, even sixty years ago, housewives in common life considered the making "tallow dips" an important part of their domestic duties. A string of wicking was dipped into melted tallow repeatedly, until the hardened fat was of sufficient size to serve as a candle. Later, tin molds were used, into which the melted tallow was poured, and a handsomer article was produced. In this country the bayberry wax, as well as beeswax, and later spermaceti, were used. These and whale oil were the only articles used for lighting houses or streets for a considerable portion of the century.

Since the first discovery of fire in prehistoric ages, when, where, or by whom, no one knows, there had been no advances made in methods of producing it, in all the ages of the past, until within a half century. The principle was the same, whether two sticks were rubbed together or flint and steel generated the spark. The wisest philosopher and the savage knew no better way. The friction match introduced a new method, and may be said to be one of the most valuable contributions to human convenience and comfort that the century has witnessed.

The invention and improvement of

wood stoves, the utilization of coal (see "Coal"), kerosene, gasoline, etc.; the development of steam heat, the use of gas and electricity, have added untold comforts to human life and bestowed upon mankind sources of domestic and social enjoyment unsuspected and undreamed of in 1800. (See "Electricity.") And it needs no prophetic vision to announce that before the twentieth century shall have achieved its noon, electricity will have taken the place of wood and coal in many of the needs of civilized life, if indeed some other agent may not be found even superior to electricity.

A hundred years ago a large part of the population of this country, especially out of cities, dwelt in log houses. Some of these houses were very large and roomy, having been built at different times and turned into one house with several rooms. Says a writer: "My memory of the middle of the century includes a large double log house with a huge fire-place something like six or seven feet wide at the mouth, and tapering back till it was eighteen inches less where the back log would be placed. This fire-place was against the north wall, and a few feet from that wall, on the east and west sides, doors. I have seen a yoke of oxen driven up close to the house with a huge back log of green birch wood, sometimes three feet through—so large that it was almost impossible that a man could handle it, or even two men. Where the oxen left it, a horse would be hitched to it. Both doors to the house would be thrown open, and the animal would be driven through the house, being stopped so that the log would be left exactly opposite the fire-place. Then he would be unhitched and driven out, the doors would be closed, and the huge back log be rolled into the fire-place. Then a forestick would be brought in and thrown upon the andirons, smaller wood be piled between that and the back log, and a fire would soon be glowing, which would send sparks up the chimney, and heat radiating out into the room. In front of this fire, over it by means of a swinging crane, and in the ashes underneath, all the cooking was done in those days, excepting where the brick oven was utilized for baking the bread and pies."

Stoves were unknown for cooking or heating until the century was well along. Not a lump of coal had ever been utilized for warmth. The infinite comfort resident in "black diamonds" had never been suspected. The sunshine that the Creator had stored away during the carboniferous epoch was still imprisoned, and peat in some localities, and wood everywhere else, constituted the fuel. The spacious drawing-rooms of the rich, and the parlors of the middle classes, as well as the homes of the poor, were heated with wood fires on the hearth. There was not a stove, except the crude sheet-iron box or iron fire-place—the Franklin—or a furnace, in any human habitation. In the coldest weather the housemates would roast on one side and freeze on the other. (See "Coal.") Think of the labor of preparing and fetching wood to prevent actual freezing in the cold-

est weather, for comfort was out of the question. Of course, churches, libraries, halls, and all public places were alike uncomfortable. Wood fires on the hearth were incapable of diffusing warmth enough to keep from positive discomfort the hovels of the poor, or even the homes of the middle classes, or the mansions of the rich. The occupant of the humblest flat enjoys greater immunity from cold than did the most favored a hundred years ago. A hole in the floor connecting with a furnace, or a steam radiator seems less poetic than the roaring log fire, but there is infinitely more comfort in it.

The revolution in the kitchen has kept pace with the progress in the parlor and drawing-room. Less than a hundred years ago the cooking-stove and range were unknown. All food was prepared on the kitchen hearth, and in every home it was cooked in pots and kettles, suspended from the crane by "pot-hooks and trammels," or the steaming roast hung before the fire in the "tin kitchen," or baker, and the boy or girl of the family sat by on the hearth to turn the spit. Sometimes steak was broiled on charcoal in the portable furnace, or bread was baked in the skillet before the fire, or on the coals — short-cake of wheaten flour, or johnny-cake or hoe-cake of corn-meal (corrupted from journey-cake, because the early settlers of this country carried the bread on their journeys) — except on Saturdays, when the huge brick oven was heated, and the regulation pork and beans, rye-and-Indian "brown bread" and wheaten loaves and pies were baked for the coming week, or, on special occasions, the spare-rib, turkey, goose, or chickens in the tin kitchen were supplemented by the contents of the brick oven.

Franklin is said to have been the inventor of the first stove. Eliphalet Nott, in 1832, invented improved heating stoves. The modern base-burner was originated in 1840, in England, by Walker; Dennis G. Littlefield, Foster, Moore, Frost, Hunt, Perry and others devised anti-clinker arrangements and improvements. Hot air, hot water, steam furnaces, gas-burners, by Boynton, Magee, Eickmeyer, etc., have introduced artificial summer into modern homes.

Contrast with the kitchen fire and skillet and frying-pan, the cooking-range, hot and cold water, refrigerator, washing machine, wringer, furnace and steam heat, gas-light and heat, laundry, electric lights, and all the comforts and luxuries of even a moderately appointed home, and what progress is revealed!

Consider, also, the discomforts of the church-goer in winter at the beginning of this century, whether in city or country. The frosts of December have penetrated and keep possession of the stone or brick, or drive through the wooden walls of the house of worship. The arctic temperature of winter pervades the room, not at all mitigated by any artificial heat. Here and there a worshiper, doubtful of the propriety of the act in the house of God, has a "foot-furnace," a small box of perforated tin, at the feet, in which

charcoal is smoldering, but the great mass of the people sit in shivering but heroic misery, while the parson prays a half hour and usually turns his hour-glass at least once during his sermon. Not a temple in Christendom was a place of comfort. How the young and the frail and tender survived such weekly tests must ever remain a problem. Furnaces were not; stoves were unheard of, and, when invented, were for a long time unadmissible in church or meeting-house. The minister's breath was a visible "pillar of cloud by day" aimed at the congregation, and the cloud of incense that rose from the lungs of his hearers must often have obscured the atmosphere. Nothing else than the internal fires of religion could have rendered divine service endurable, or sustained the health, or even life, of the worshiper. What a contrast between then and now! An artificial summer is maintained in the poorest sanctuary. First the rude box-stove, then later improvements, and at last the furnace came, and banished physical torment from the place of worship, and now the poorest of the poor is sure of warmth and cheer for the body, as well as comfort for the soul, when he turns his feet toward the Sunday service. There are few places where the contrast beween 1800 and 1900 is greater, or more gratifying, or more conducive to human improvement, than the cold, dismal places of torment where men worshiped God then, and the comfortable, grateful atmosphere of the places of prayer and praise now.

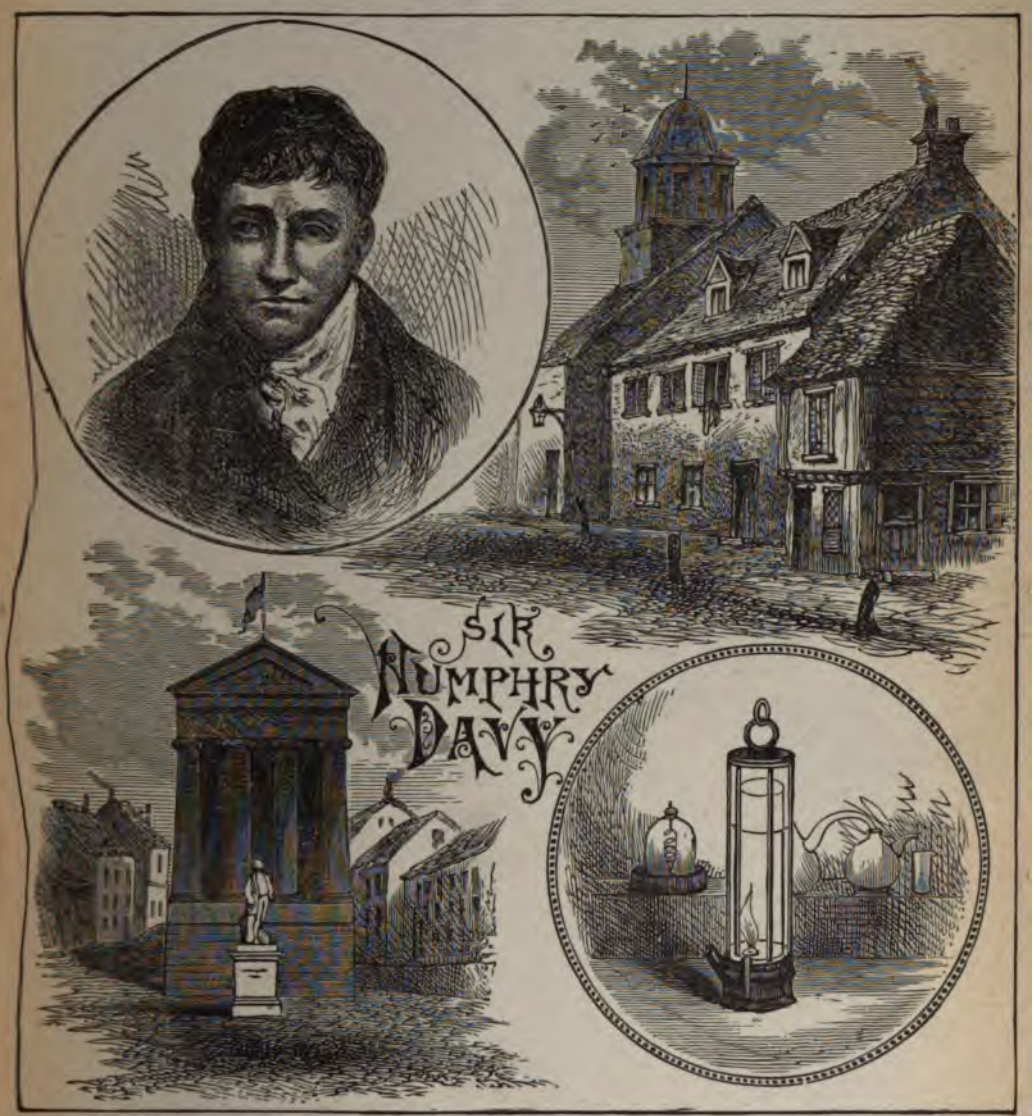
The "Boston Journal of Chemistry" says, "Our fathers were groping in almost outer darkness, so far as a knowledge of the sciences was concerned; and but little progress had been made in invention and the arts. Scarcely one of the modern contrivances for cooking, and for warming and lighting dwellings, was known. Not a pound of coal or a cubic foot of illuminating gas had been burned in the country. No iron stoves were used; and no contrivances for economizing heat were employed until Dr. Franklin invented the iron frame fire-place which still bears his name. All the cooking and warming in town and country were done by the aid of fire kindled upon the brick hearth, or in the brick oven. Pine-knots or tallow candles furnished the light for winter evenings; and sanded floors supplied the place of rugs and carpets. The water used for household purposes was drawn from deep wells by the creaking "sweep"; and it is a curious circumstance that both the well and the building meeting the necessities of a water-closet were often at long distances from the house. On a cold, windy night in winter, to be called toward one of them was something dreadful to think of. No form of pump was used in this country, so far as we can learn, until after the present century. There were no friction matches in those early days, by the aid of which a fire could be speedily kindled; and if the fire went out upon the hearth over night, and the tinder was damp so that the spark would not catch, the alternative remained of wading through

the snow a mile or so, to borrow a brand of a neighbor. Only one room in any house was warmed, unless some of the family were ill; in all the rest the temperature was zero during many nights in winter. The men and women of a hundred years ago undressed and retired to their beds at night in an atmosphere colder than that of our modern barns and wood-sheds, and never complained. No hot-air furnaces or steam-pipes tempered the wintry air in their dwellings; and they slept soundly in the cold. The cooking was very simple, and the nature of the food plain and substantial. But few dishes were seen upon the table; pork and cabbage, corn-bread and milk, with bean-porridge, were the every-day forms of food consumed."

The wealthiest homes, the palaces of nobility and royalty, were not supplied as now are the homes of myriads of working people, mechanics, and those in humble life, with hot-water pipes always on tap, with furnace, or steam, or hot water for warming purposes, and with gas or electric light. It only requires such reminiscences as these to quench mistaken eulogies on "the good old times"; and to convince us that "to-day is better than yesterday," a sure prophecy that "to-morrow will be better than to-day."

SIR HUMPHRY DAVY.

[Born 1778. Died 1829.]



Sir Humphry Davy was one of those natural philosophers who specially contributed to the formation of modern thought. Without attaining to the highest distinction, his faculties were so well balanced, and his discoveries so numerous and brilliant, that he may be regarded as a representative man of his time and a pioneer of experimental philosophy in its latest developments.

CHAPTER II.

COAL, GAS, COAL OIL, AND LAMPS.

FIRST USE OF COAL—INVENTION OF GAS—DISCOVERY OF COAL OIL—PARAFFIN —ANILINE DYES—IMPROVED LAMPS, BURNERS, ETC.

THE discovery and utilization of coal is perhaps the chief factor in the general progress of the century. Coal was not considered of practical utility until at a

HAULING WINTER FUEL.

very recent date. The first coal-fields worked in America were the bituminous fields at Brighthope, Va., near Richmond, discovered in 1750. This coal was used at Westham, on the James River, to make shot and shell during the War of Independence. The first use of anthracite coal was in 1768-69, and for smithing in 1790. But coal was not used for warming purposes until 1808, and then in common grates, for there were no stoves. The first successful use of anthracite coal for the smelting of iron was in 1839, at the Pioneer Furnace, at Pottsville, Pa. It had been tried on the Lehigh in 1826, but was unsuccessful. The great shaft of the Philadelphia and Reading Iron Company has been sunk to a depth of 1,569 feet from the surface to the great mammoth coal vein, which attains a thickness of 25 feet, in that distance passing through no less than fifteen coal seams, of which six are workable, and have an average thickness together of sixty-four feet. Even then there are coal-seams underlying these.

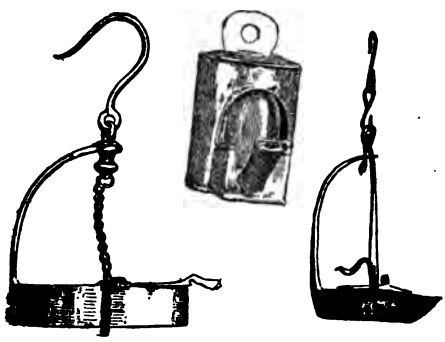
A century ago people had no means of warming or cooking but by wood, sold by the load, or by peat or turf. In fierce winters, when the rivers were frozen, wood was brought on sleds to cities from the country. It was not until 1830, at a time when the price of wood was enormous, that anthracite coal came into general use. For cooking purposes it was hardly in use until 1830-40.

There are now between 80,000

PRIMITIVE METHOD OF COOKING.

and 90,000 different kinds of stoves for cooking and warming in use, mostly on this continent, for stoves are not in common use in Europe.

A firm in Chicago keeps in stock for repairs the parts of 80,000 different kinds of stoves. Mica fronts were first inserted in heating stoves in 1807, by Pollok. In 1830, in England, Eliphalet Nott made great

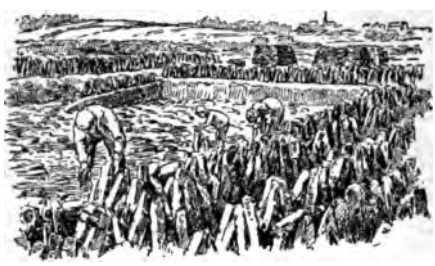


LAMPS USED 100 YEARS AGO.

improvements. Harper and Walker invented the base-burner in 1839.

Coal is fossil vegetable matter, and is the source of modern civilization. It heats our dwellings, moves our machinery, and, in fact, but for it the great progress of the first three-fourths of the century would have been impossible. It is, as George Stephenson said, "bottled sunshine," for the sun stored its heat in the vegetation of the carboniferous epochs, which, by carbonization and pressure, became coal, and the process of combustion releases the chemical elements, and is the reverse action to that of the sunlight,—it separates the carbon and oxygen which the sun united in the coal. And just as pessimistic prophets were prognosticating the time when the supply of coal would be exhausted, along comes electricity and indefinitely postpones the catastrophe. Meanwhile, aside from the heat which the combustion of coal yields — a benefaction that practically belongs to this century, for its utility was not before suspected—see what other contributions it has made to man's improvement, almost within the memory of those yet living, wonderful sources of human development that lay unsuspected at the very doors for thousands of years. The Pelion upon Ossa of discovery that recent years have reaped vindicate the prophecy of Professor Berthelot, that in the golden age that is coming we shall draw all our heat, and the mechanical forces which result from its conversion, directly from the earth itself—that instead of digging 2,000 feet for coal, we shall dig a little farther when the coal gives out, and bring up the heat itself by thermo-electric methods.

Coal-gas came into use early in the century—though the century was far advanced before it superseded other methods of lighting and heating. It was supposed to be man's final achievement in illumina-



GATHERING TURF.

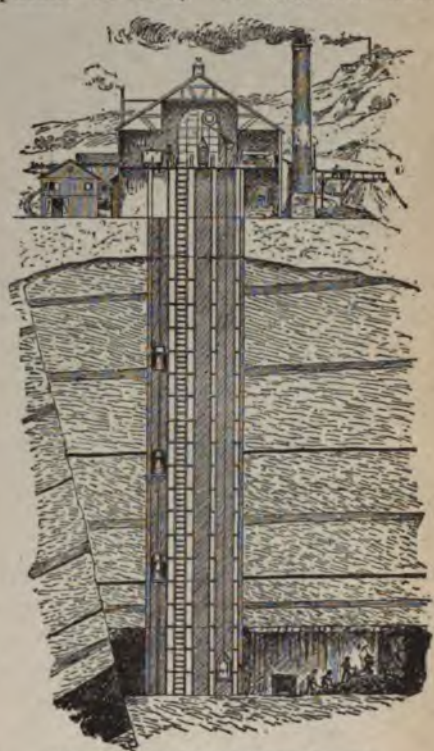
tion, when, in the last fourth of the century, electricity came to the front, and, as we write, gas is everywhere retiring before the newcomer. In 1817 the first gas-meters were used, substantially like those

now in vogue. The wet gas-meter, that measures the quantity of gas that passes through it, invented by

AN ACCIDENT IN A COAL SHAFT.

Clegg, in 1807, was perfected by Crosley, in 1815. The dry-meter was invented by Malam in 1820, and improved by Defries in 1838. Many improvements and variations have been added since.

The idea of gas-lighting first took definite shape in the mind of William Murdoch, who, in 1792, lighted his house in Cornwall, England, and in 1798 constructed an apparatus for lighting a manufactory near Birmingham, which was illuminated for the public in 1802, to celebrate the declaration of peace in Europe. An eye-witness of the spectacle writes: "The illumination of Soho Works on this occasion was one of extraordinary splendor. The whole front of that extensive range of buildings was ornamented with a great variety of devices, that admirably displayed many of the varied forms of which the gas-light was susceptible. This luminous spectacle was as novel as it was astonishing; and Birmingham poured forth its numerous population to gaze at, and to admire, this wonderful display of the combined effects of science and art." From that time on gas-lighting increased until the advent of electric-lighting. The projector of street-lighting with gas was Frederick Albert Winsor He took out a patent in 1804. It was not until



INTERIOR OF A MODERN COAL MINE

1807 that gas was used to light the streets of London. It was fought with great bitterness. Its use

would throw thousands of sailors, rope-makers, and others out of employment—it was thought—by destroying the whale fisheries. But it won its way, and soon superseded oil lamps in the streets of cities, and

ROBERT WILHELM BUNSEN.

banished the haunts of crime that lurks wherever darkness affords a shelter. London Bridge was gas-lighted in 1813; Boston was first lighted with gas in 1822; Philadelphia in 1835.

Before gas came torches and uncouth tin lamps fed with whale oil, and cups containing animal grease, gave outdoor illumination. Gas mains were first laid in London in 1814. At first, with the usual stupidity of scientific men, Davy, Wollaston, and Watt declared that "coal gas could never be safely applied to the purposes of street-lighting!"

Samuel Clegg devised a method of purifying coal-gas from sulphuretted hydrogen, which had made its odor very offensive. He passed the gas through lime-water, before entering the gas-holder. Winsor, Murdoch, Clegg, Accum, and others, re-inforced by philosophers, engineers, chemists and other experimentalists, soon developed the new discovery into comparative perfection. In fact, it seemed as if artificial lighting could no further go, when the electric light flashed its radiance on an astonished world.

Of course, all the appliances of gas have been developed within a very few years—burners, heaters, "gas-logs," cooking ranges, etc.

The inhabitants of cities can scarcely imagine the dirty, smoky streets and public halls and churches, and the average homes, before the advent of coal-gas, when candles and whale-oil lamps supplied the artificial light. Every street pedestrian on moonless nights carried his lantern, and such lanterns! cylinders of perforated tin, which did little more service than to attract attention to himself. It is no wonder to us that the discovery was hailed with rapture.

Prof. T. S. C. Lowe, of Pasadena, Cal., invented water-gas, that now

FLINT, STEEL AND TINDER BOX.

constitutes 70 per cent. of the gas used in this country. The invention has made millions for those who have entered the business, and has saved

other millions to the consumers of gas. In 1897 he patented a system of coke and gas manufacture that seems destined to completely revolutionize the present methods, as his water-gas process revolutionized the old system.

A CANDLE MOLD.

In recent years natural gas has been discovered in several states in this country. It is conveyed long distances in pipes for purposes of lighting and heating. Natural gas was first piped in 1884, for domestic and mechanical uses.

In 1850 whale oil had become so scarce as to retail at $2.50 a gallon, and the question of domestic lighting became a serious one. The distillation of coal produced an oil that cost $1.00 per gallon. It gave good light, but was expensive, and gave an unendurable smell. In 1847, James Young, in Derbyshire, Eng., bored and found oil, seven or eight years before James M. Townsend and E. L. Drake, of New Haven, Conn., found and sent for examination some rock oil, or petroleum, brought from Oil Creek, Penn., to Professor Silliman, in 1854. The report was so favorable that land was leased along the creek in order to procure the new "rock oil," but the business crash of 1857 interrupted the enterprise. Drake and Townsend organized the "Seneca Oil Company," to sell the oil for medicinal purposes. Soon they began to bore for oil, and August 29, 1859, the auger, at the depth of 65 feet, struck a flow that yielded to the pump 500 gallons a day. It at once banished all other methods of illumination except gas. By 1860 a thousand wells had been bored, and an enormous yield obtained. The amount in 1891 was 54,291,980 barrels. It is now abundant in several states. One well has yielded 25,000 barrels a day. The preparation of petroleum, benzine, naphtha, gasoline, burning fluid, kerosene, all products of coal, at once banished whale oil and candles, and became the illuminating agents everywhere, as well as fuel for engines, boats, etc. From this time on coal oil has been the chief lighting fluid in America. The introduction of kerosene added several hours a day to millions of people, was an incalculable blessing in the

A CANDLE BOX.

preservation of eyesight, and in the evening hours of reading and study it gave it has added untold advantages to human progress.

How well the writer of these lines, and thousands of his contemporaries, remember the satisfaction with which the several steps of progress

from candles and whale oil were hailed—lard oil, comparatively well-odored, though in winter subject to the hardening effects of frost; camphene, luminous but dangerous; burning-fluid, a close relation of camphene; kerosene, comparatively harmless and an almost universal necessity; gasoline, a most risky servant; and then gas, supposed to be the final achievement as a means of artificial light,—and now, what can go beyond the electric light? Who dares prophesy?

A passing reference may be made to the value of kerosene, even yet one of man's most useful servants, especially in the remote places where gas or electricity are not (now, but for how long?) available. When the kerosene lamp was a necessity in nearly every home, Col. E. F. Jones, who commanded the famous Sixth Massachusetts in its "march through Baltimore," invented the little ratchet that turns the wick up or down, and when the war broke out. was receiving one cent royalty on each lamp manufactured, which yielded him a princely revenue. This illustrates the readiness with which the human mind adjusts itself to human needs in this Age of Invention, and shows how valuable to the inventor is any invention, however simple, that furnishes an article that meets a general want.

Reichenbach (1798-1869), in experimenting with heating wood in close vessels, found a white, translucent substance which he called paraffin. Subsequently it was found in coal. In 1847 Lyon Playfair (1819-——) directed attention to petroleum issuing from a mine in England. On distillation it yielded a yellow oil which, cooling, proved to be solid paraffin. In 1850 James Young obtained a patent for producing paraffin from bituminous oil. It is also obtained from ignite. From paraffin, candles are made in great quantities—thousands of tons annually. They are very clean and beautiful, and are scarcely inferior to those of wax. Candles have also been made of spermaceti and stearine. Paraffin is also used as the lining of beer-barrels, and in the preservation of fruits, etc., and for other purposes.

Phenol, one of the constituents of coal tar, is better known as carbolic acid. This great disinfectant and antiseptic was discovered by Runge, in 1834. It is known to be highly poisonous, but it arrests the process of putrefaction in animal and vegetable matter, and is one of the greatest of antiseptics.

The evolution of a large number of most exquisite dyes from coal-tar is among the singular triumphs of the century. The aniline dyes are famous among colors in modern use. Chemistry has extorted them from the apparently worthless slag of the furnace. Aniline itself is small in amount, but with it are found benzol, toluol, phenol, naphthalene and anthracene. Faraday, in 1825, discovered benzol, or benzine. Aniline was found in coal-tar in 1834. In 1856 W. H. Perkin (1838——) obtained from aniline the first coloring matter, which is now known as mauve. Later he developed other colors. In 1859 Nergrim, of Paris, produced magen-

ta, and in 1860 Medlock, of England, by the addition of arsenic acid, perfected the process of producing magenta dyes; and of the same unpromising base chemistry has produced "Nicholson's blue," "violet imperial," "dahlia," "Britannia violet," "aniline green," and in fact many of the gorgeous colors known to the modern art of dyeing—blues, violets, reds, yellows, greens, browns—developed by chemistry from what, until 1856, was considered useless rubbish.

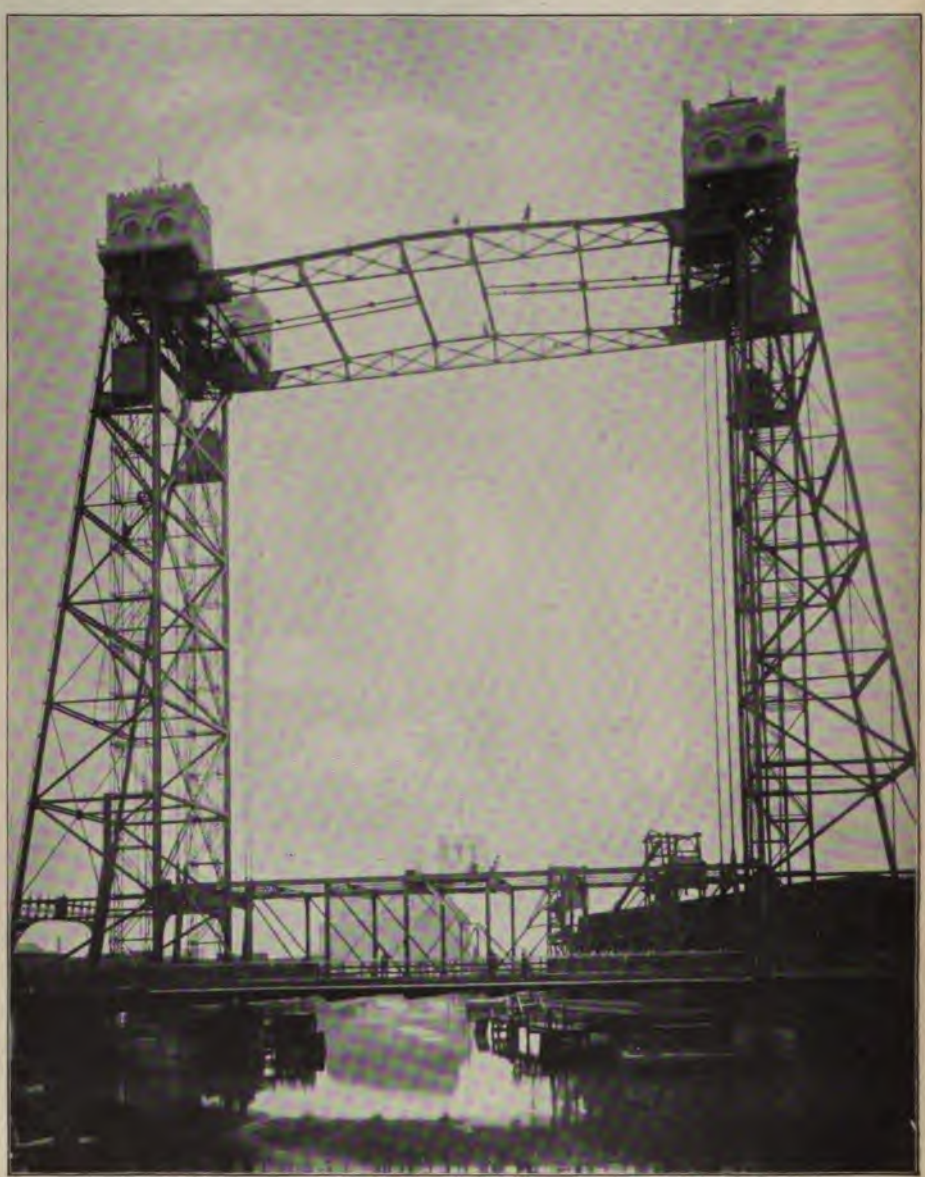
Improved methods of lighting are numerous. The Bunsen burner feeds the gas-flame at the bottom with oxygen, so as to greatly increase its volume. The Welsbach is a greatly improved burner, and an incandescent burner invented in 1898 dispenses with the chimney. The improvement consists of a special form of Bunsen burner, which, in giving a more intimate mixture of gas and air, even at a higher pressure than before, meets all the needs of a chimney. The light-giving power of the new burner is about twenty-five to thirty candle-power per cubic foot of gas consumed. The Argand burner, which draws a current of air into the center of the flame, was in general use first about 1830. Whale oil, of course, fed the flame. The Drummond light was invented by Prof. Drummond in 1826. It is the intensest light known. It is caused by a stream of oxy-hydrogen gas poured on quicklime. The Fresnel light was invented by Fresnel in 1810. It is a four-wicked lamp, with plano-convex lenses and octagonal glass prisms. The flame is in the focus of the lenses. Dobereiner's lamp is an instrument invented by Professor Dobereiner in Jena, in 1824, for obtaining light by the projection of a jet of hydrogen upon a piece of spongy platinum. Spongy platinum very readily absorbs gases, and more especially oxygen, and the hydrogen being brought into close contact with oxygen derived from the air, a chemical union, accompanied with light, takes place.

Acetylene gas is a comparatively new product and is made from calcium carbide, a new chemical combination. The carbide is produced by taking common lime and coal and subjecting them to a temperature of about 5,000 degrees. The product is the base from which the gas is made, the only addition necessary being water, for which the carbide has a strong affinity. As the water is added the gas rises, and without other addition or treatment is at once fit for use. The most conspicuous use of acetylene is just now in bicycle lamps. In 1895 F. S. Wilson, of North Carolina, invented this product, destined to become of great value as an illuminant.

No one article is the source of so much usefulness in the practical and fine arts, and in medicine, and so productive of life's comforts and luxuries, as coal. And its usefulness is due to the inventive genius of the Nineteenth Century. It may truthfully be said that the Nineteenth Century would have been impossible without coal and its derivatives.

If the reader will, in imagination, roll backward the scroll of time, and endeavor to see himself without coal and its derivatives, as sources of warmth, and with which to prepare food, depending entirely upon wood, or its wretched substitute, peat or turf; if he will see women everywhere bending over kitchen hearths and cooking before blazing wood fires, and lifting ponderous kettles from pot-hooks and trammels; if he will fancy himself in winter's cold roasting one side before a roaring flame while the other side is freezing; if he will realize women with their needles, scholars over their books, and all pursuing their avocations depending on the firelight, or the dimly-burning candle, or the wretched wick of the ill-smelling whale-oil lamp for light, before the advent of electricity, gas, or even coal-oil, he will obtain a faint idea of the progress of the hundred years now closing, in the commonest necessities and comforts of daily life. To be transported back to such conditions as prevailed less than a hundred years ago, would be to journey a long distance on the road to semi-barbarism. If, in addition, he will consider the metals that are shaped, the machinery that is moved, the vast mechanical enterprises that are only possible through the utilization of the carbon which man's ingenuity has released from its imprisonment in the coal—all within five score years—he will have a hint, at least, of the century's development.

A STEAM-HAMMER.
"A stroke of 16 feet and a weight of 250,000 pounds."



A LIFT BRIDGE.

"Like a huge elevator, the bridge rises high enough to allow the largest ship to pass underneath."

CHAPTER III.

IRON AND STEEL.

FIRST IRON BRIDGE—IRON AND STEEL IN ARCHITECTURE—STEAM-HAMMER—NASMYTH—BESSEMER—FIRST STEEL RAILS—FIRST IRON AND STEEL BRIDGES—BARBED WIRE.

THE king of the useful metals was an obstinate and unwilling servant of man before the discovery of coal. It could be shaped into very few articles, comparatively, until it was made ductile, almost plastic, by the subduing power of coal. In a hundred years its uses have been myriad-fold increased.

Iron was produced only in a small way, comparatively, during the last decade of the eighteenth century. The first iron foundry in Pittsburg, Penn., was established in 1803, but the manufacture was slow, as charcoal was the fuel. In 1840 anthracite and bituminous coal superseded charcoal, and since then the business has enormously developed. Attempts at forging iron on a large scale were not successful until James Nasmyth, in 1838, invented the steam-hammer. Necessity gave birth to this invention. The famous "Great Eastern" steamship was being built, and no hammer in existence was able to shape the paddle-shaft. Nasmyth was equal to the occasion, and his hammer was produced; but just as it was completed the screw-propeller succeeded the paddle-wheel, and the hammer was not used on the job for which it was invented, but it came into extensive use in all iron manufacture. It can give a blow of a ton's weight, or a gentle tap that will not break an egg. James Nasmyth was born in 1808, in Edinburgh, and established a manufactory for machinery in 1834. He was the inventor of the pile-driver. The hot-air blast was patented in 1828, in Glasgow, by James Neilson. It revolutionized iron smelting William Neal Clay, in 1837, produced wrought iron direct from the ore. Similar results were accomplished by James Renton, in this country, in 1851; by Frederick Yates, England, 1850, etc.

The employment of iron in house-building, ship-building, cannon, and in all large work, has been wonderfully increased by the invention of the steam-hammer.

Within a few years iron has been used in building houses as never before. Sir William Fairbairn first suggested iron girders. Since then iron and steel have come to occupy a large place in building operations. From the railroad iron laid on the tops of piles, on which to build the piers of great buildings, to the walls, enormous edifices are erected

of a height, lightness of weight, and solidity—and fireproof withal—not possible even fifty years ago. Build-

JAMES NASMYTH.

ings occupying acres, nearly all iron and glass, are miracles of architecture, wrought by the builders of the present century for the first time.

The manufacture of steel is a modern attainment. In 1823 M. Adrien Chenot, France, invented a process of manufacturing steel direct from ore, but it was too expensive for practical use. In 1839 Heath (England) combined carbon with manganese to produce a carburet, to change iron into steel. He did not patent the process, and the Sheffield manufacturers fought him, and he died broken-hearted, after years of litigation. Others accomplished the same result in other ways, Bessemer, Krupp, etc.

Bessemer steel was invented by Henry Bessemer (1813-1898) in 1856. The process consists of blowing a blast of air through melted iron, which converts it into steel. Before the invention only 50,000 tons of cast steel were produced annually in Great Britain, costing $250 to $300. per ton. In 1889 Great Britain produced 2,140,791 tons, of which 943,083 tons were made into rails, at $25. a ton. The steel is stronger than the best iron, and has now almost banished iron for building ships, bridges, etc. It has revolutionized the iron trade of the world, and yet it was regarded as a visionary scheme until Bessemer, after receiving the opposition of the iron trade of Sheffield, built works of his own, and compelled the recognition of his invention. His income was at one time $500,000 a year. Bessemer steel is now everywhere regarded as of great value to the world. And it has been estimated to have saved to the world, in twenty-one years, $5,000,000,000. Bessemer

HENRY BESSEMER.

also invented a type-casting machine, a machine for making Utrecht velvet, and other ingenious devices. He deserves a high seat

among the inventors of the world, for he did for the steel industry what Newton did for astronomy, and what Darwin did for natural science.

Steel is a compound of iron and carbon, midway between wrought and cast iron, with the most valuable properties of both. It was produced at great cost before this century. In 1856 Bessemer suggested to the British Association forcing currents of cold air through fused iron, and thus removing the carbon and silicon, and manufacturing steel. His patent dates October 17, 1855. The process was not perfect, when Mushet suggested adding spiegel at the end of the operation, and, in 1878, Gilchrist Thomas and Snelus substituted for the gannister lining of the converter, magnesian limestone. Another process is the Siemens-Martin, which sends hot air through the molten metal by the regenerating furnace; and in 1880 the basic process was invented by Sidney Gilchrist Thomas.

The ordinary practical test applied to distinguish iron from steel is the ascertaining whether the substance hardens on heating and quenching in cold water, becoming again softened on reheating and cooling slowly; a substance which does this may fairly be regarded as steel (possibly of very bad quality, but still steel), while one which does not may be fairly regarded as a soft iron.

A STEAM-HAMMER IN OPERATION.

In 1831 Howells, an American, invented a process of rendering malleable iron direct from the furnace.

The rotary puddler was invented in 1867, by Danks, of Cincinnati. The Oxyhydrogen Blowpipe is one in which not common air, but a mixture of oxygen and hydrogen, is used. These being made to issue from two separate reservoirs and afterward unite in a single jet, or to pass from a common bladder through the safety-jet of Hemming, are then directed through the flame, with the result of producing a heat so intense as to fuse various bodies which are found quite intractable under the ordinary blowpipe. The Oxyhydrogen Blowpipe was invented in 1802 by Prof. Robert Hare, of Philadelphia.

One of the great advantages that the steel rail has conferred upon railroads everywhere is an increased speed of trains, with a proportionate decrease of risk. Laid on a well made and solid road-bed the best steel rails enable powerful locomotives to draw heavy trains safely at a rate of speed that would have been considered dangerous two or three decades ago. Were it not for the steel rails laid all the way between New York and Chicago the New York Central would not now be sending its daily flyer from one place to the other in twenty-four hours, and the Pennsylvania Railroad would not be experimenting with a twenty-hour train between the same points, nor the Santa Fe flyer accomplishing the distance between Chicago and Los Angeles in sixty-six hours. The first Bessemer steel rails used in the United States were put down in 1865. (See "Steam.")

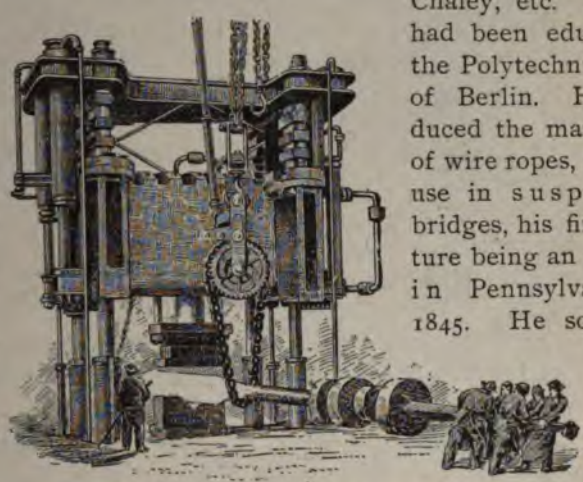
With the demand for greater speed on the railroads there has come a gradual increase in the size and weight of the rails. The first railroads in this country had rails that weighed twenty-eight pounds to the lineal yard. They are now sometimes eighty-five and even ninety and one hundred pounds to the yard.

Bessemer's first invention was a stamp for the cancellation of letters.

The necessity for such an invention was suggested to him by his sweetheart, who was afterward Lady Bessemer. It is the stamp that is used by every postoffice in the world, and has saved millions of dollars for many governments. (See "Postage.") When Bessemer was twenty years old he had not enough saved to marry his fiancée, but he was resolved that he would have it soon. He invented a machine to produce figured Utrecht velvet, a machine to make type, and the apparatus which is used for the manufacture of bronze powder. This gave him wealth. The raw material of the powder cost 22 cents a pound, and the powder, imported from Germany, $30.00 a pound. He was two years perfecting this machine. He did not patent it, and the powder was made by himself and a few friends, who carefully guarded the secret. The profits were as high as 1,000 per cent. on the investment. He studied oils, varnishes and sugar. He sought to improve the speed of railroad trains, and designed a train to go at the rate of 100 miles an hour. These experiments were stopped by the ditching of the train. But the result was that the "luggage van" was introduced in England,

and the carriage of baggage on the top of the coaches abandoned.

Iron and steel in bridge building, especially suspension bridges, has produced marvels of construction, spanning spaces that at the beginning of the century would have been deemed impossible. The first suspension bridge the world ever saw was built across the Tweed, in Berwick, in 1819, by Sir Samuel Brown, a span of 449 feet. The bridge across Menai Straits, by Thomas Telford (1757-1834), was 580 feet; Roebling's, over Niagara river, is 245 feet above the water, and 821 feet span. The famous Brooklyn bridge is 1,595 feet span of the suspension, and in all 3,475 in length. The tallest masts pass under this gigantic structure. The Clifton, at Niagara, had, when built, the longest span in the world—1,268 feet, 4 inches between towers. It was built by Samuel Keefer, and was opened for traffic January 1, 1869; the main cables were 1,888 feet long. It was destroyed by a hurricane. The Forth Bridge and the London Tower Bridge are magnificent specimens of modern bridge construction.



SHAPING IRON BY HYDRAULIC PRESSURE.

These and multitudes of other bridges all over the world are almost entirely of iron or steel, and but for the application of that metal and the co-operation of coal, both children of the century, they never could have been bulit. They are light, strong, secure, convenient, graceful, and every way illustrate the mechanical genius of man.

Among the modern geniuses in bridge construction should be named James B. Eads (1820-1887), John A. Roebling (1806-1869), George Stephenson, W. Fairbairn, Brown, Chaley, etc. Roebling had been educated in the Polytechnic School of Berlin. He introduced the manufacture of wire ropes, and their use in suspension bridges, his first structure being an aqueduct in Pennsylvania, in 1845. He soon after built other aqueducts of the same kind, and the suspension bridge across the Monongahela, at Pittsburg. His first great work was the suspension bridge across Niagara river, which was completed about 1855; and in 1867 he completed the suspension bridge at Cincinnati. He appropriately finished his colossal works by furnishing the design for the great bridge connecting New York and Brooklyn. Capt. J. B. Eads, of Brooklyn, was the builder of the St. Louis bridge—one of the greatest of all bridges. Captain Eads's jetties for deepening the

Mississippi are ingenious inventions.

The Cantilever bridge is a very modern structure. That which spans the Niagara river, just over the head of the Whirlpool Rapids, and in full view of the cataract, is the first bridge of the kind ever built. It is constructed entirely of steel. Its essential principle is that of a trussed beam, supported at its center on a steel tower, the landward end being securely anchored. The cantilever arms meet each other at the center of the bridge. It cost $900,000.

Undoubtedly Robert (1803-1859), son of George Stephenson, originated the great scheme of modern bridge-building. The tubular bridge was his idea.

Some of the remarkable bridges in the world would have been forever impossible but for the use of iron or steel. They are the Brooklyn bridge, the largest suspension bridge in the world, commenced under the direction of J. Roebling, in 1870, and completed in about thirteen years. It is 3,475 feet long and 135 feet high. The cost of building was nearly $15,500,000. The Niagara Suspension bridge was built by Roebling, in 1852-55, at a cost of $400,000. It is 245 feet above water, 821 feet long, and its strength is estimated at 1,200 tons. The bridge at Havre de Grace, over the Susquehanna, 3,271 feet long, is divided into twelve wooden spans, resting on granite piers. Coalbrookdale bridge, England, was the first cast-iron bridge. It was built over the Severn in 1779. The Tubular suspension bridge, over the Menai Strait, forming part of Chester and Holyhead railway, consists of two lines of tubes, each 1,513 feet long, is supported on three towers, besides the shore abutments, and is 100 feet above the sea. Its weight is 10,540 tons. It was finished in 1850. Tay bridge, 10,612 feet of eighty-five spans, across the Tay, 90 feet above the sea, was completed in 1877. Cost $10,750,000. Destroyed by a gale in 1879. Rebuilt. Clifton suspension bridge, at Bristol, England, has a span of 705 feet at a height of 245 feet above the water. The carriageway is 20 feet wide, and the footways 5½ feet wide. Cost $500,000. Forth bridge, over the Firth of Forth, near Edinburgh. Total length, 2,765 yards (1⅓ miles). There are two cantilever spans of 1,710 feet each (the longest in the world). Fifty-one thousand tons of steel. Extreme height above mean-water level, over 370 feet. About twenty-five acres of surface to be painted. Cost about $15,000,000. Commenced April, 1883; opened by Prince of Wales, March 4, 1890. High bridge, New York, by which Croton aqueduct is carried across Harlem river, is of granite throughout. It is 1,450 feet long, 114 feet high, and supported on fourteen massive piers. Victoria bridge, which spans the St. Lawrence at Montreal, Canada, is tubular, and 9,194 feet, or nearly two miles long. The massive tube through which the railway track is laid is 22 feet high and 16 feet wide. It was formally opened in 1860. The total cost of the bridge was $6,300,000. The St. Louis bridge, across the Mississippi river, from St. Louis,

Mo., to East St. Louis, Ill., is regarded as one of the greatest triumphs of American engineering. It was designed by James B. Eads, and was begun in 1869 and completed

GUSTAVE EIFFEL.

in 1874. It consists of three spans, resting on four piers. The piers are composed of granite and limestone, and rest on the bed-rock of the river, to which they were sunk through the sand from 90 to 120 feet, by the use of wrought-iron caissons and atmospheric pressure. The center span is 520 feet, and the side ones are each 500 feet in the clear; each of them is formed of four ribbed arches, made of cast steel. The rise of the arches is 60 feet, sufficiently high to permit the passage of steamboats at all stages of the water. The bridge is built with two platforms, the lower one containing a double car-track, and upper one two eight-footways and a carriageway 30 feet in width. It passes over a viaduct of five arches (27 feet span each) into Washington avenue, St. Louis, where the lower roadway runs into a tunnel 4,800 feet long, which passes under a large part of the city. The total cost of the bridge and tunnel was over $10,000,000.

A. T. Hay invented the first all-steel bridge. He died January 2, 1895.

Stone or brick was the only material of which permanent bridges were constructed before the present century, except at the close of the last century, when cast-iron began to be employed. But while cast-iron has a tenacity of eight tons to the square inch, wrought iron has thirty, and iron wire forty.

The Crystal Palace, in Hyde Park, England; the Eiffel Tower, Paris, 1,000 feet high, built by Gustave Eiffel; the great structures of the Chicago World's Columbian Exposition (1893), including the Ferris Wheel, 250 feet in diameter, with

ANDREW CARNEGIE.

thirty-six carriages, each seating forty persons, and each revolution carrying 1,440 people 250 feet in the air; the "sky-scrapers" in New York, Chicago and other cities; the

skeletons of many buildings, are but hints of the use of iron in architecture which characterizes the present century. (See "Architecture.")

The manufacture of plain, barbed, or woven wire, nails, pins, tacks and a thousand and one small articles, that last century were slowly and laboriously manufactured by hand, are all wrought a hundred times faster by the most ingenious machinery. Says Wilkie, in his "Great Inventions": "The manufacture of wire is a case in which machinery occupies itself with the minute. Formerly, wire was cut out of sheet iron with infinite slowness; now it can be be drawn at the rate of three to six feet a second. Without this machinery the telegraph system would be an impossibility, or else would have been constructed at such a cost as to render impossible its popular employment." Tacks, whose utility is universal, and whose use is indispensable, are made by machinery at an incredible rate of speed. Knight says that it is not an uncommon occurrence for an English tack-maker to forge 1,200 tacks so small that they may be contained in the barrel of an ordinary goose-quill.

"When poor William B. Hunt first conceived the idea of putting spurs upon fence wires, how little he realized how big an invention he had made; and when, after getting his patent and attempting to sell town, county and individual rights to his farmer neighbors, they all as a rule laughed at him, declining to purchase, until he became more than half inclined to doubt the value of the invention. But after a time the idea was taken up by other ingenious men, who simplified the construction and put barbed wire to use, and soon demonstrated its great value." The first patent was procured by L. B. Smith, in June, 1867; the next by Michael Kelly, in February, 1868; the next by J. F. Glidden, in November, 1874. "It has now become an article of immense manufacture and use; and the question is already settled, beyond a doubt, that it is, and is to be the standard common farm and ranch fence for all time to come, for the reason that it is cheap, effective and durable, and the material for its fabrication can never be exhausted or diminished. Thus barbed wire is saving many hundreds of millions of feet of lumber fencing every year, and when it is recollected that the fences of the United States are shown by statistics to have cost $2,000,000,000, and that, as an average, they have to be rebuilt once in fifteen years; when this immense and continuous outlay is borne in mind, the value of the barbed wire invention can be more nearly understood, as also the saving of fencing lumber as well. Thus the barbed wire inventors are among the greatest benefactors of the present generation, beyond all doubt, notwithstanding the fact that an occasional careless animal gets scratched." J. F. Glidden (1813, —) saw the earliest of the barbed wire patents in 1867, and patented the device which is now universally used for fencing. At first he cut the barbs by hand and extemporized a process by which they could be ar-

BROOKLYN BRIDGE.

"Iron and steel in bridge-building have produced marvelous constructions."

A GRAIN ELEVATOR.

"The reception and distribution of grain is one of the greatest industrial agencies of the century."

ranged on the wire. Thirty feet of this ugly and spiteful string was made and was erected in Mr. Glidden's back yard. The inventor ap-

THOMAS BLANCHARD.

plied for a patent in 1873, and received his letters in 1874. The invention brought immense wealth to its parent.

Wire nails were first made in 1884.

Sir Joseph Whitworth is the author of the idea of making all screws of the same pitch thread, and also dies for the manufacture of screws. The invention of the lathe slide-rest by Maudsley revolutionized mechanical art by making it possible to produce perfectly true surfaces. It was first intended to apply to the manufacture of screws, but was soon adapted to all shapes in wood or iron. Whitworth's drilling machine, and planing machine, Blanchard's lathe, sawing machines, such as fret-saws, jig-saws, circular saws, etc., have advanced the mechanical arts incalculably.

The various processes of producing iron and steel, the ingenious tools for making it, and the almost infinite uses to which the metal is put, emphatically entitle the Nineteenth Century to be known as the Iron Age. To enumerate them all would render this volume inordinately cumbersome. Iron working tools are entirely the achievement of the century. Tools for boring, drilling, riveting, shearing and planing iron were unknown a hundred years ago.

Therapeutic Uses of Iron. — The use of iron in the cure of disease dates from a very early period. Pliny speaks of its medicinal effects, and there is reason for believing that it was administered several centuries before his time. But Sydenham was the first to point out its most important therapeutic property, its blood-restoring power. "To the worn out and languid blood," he says, "it gives a spur or fillip whereby the animal spirits which before lay pros-

SIR JOSEPH WHITWORTH.

trate or sunk under their own weight are roused and excited."

The discoveries during the century have caused iron to become one of the most valuable of therapeutic agents.

The blood is composed of a fluid

wherein float roundish red bodies, the blood corpuscles, which play a leading part in those tissue changes essential to life. Each corpuscle consists of a stroma permeated by a red fluid, hæmoglobin, which has the remarkable property of readily combining with either oxygen or carbonic acid, but so loosely that under slightly altered conditions these gases are as readily separated from it. In the lungs the corpuscles, through their hæmoglobin, take up oxygen, which they carry to all parts of the body. But in the presence of the vital processes of disintegration and repair constantly going on in the tissues, the corpuscles yield up the oxygen they have brought, and supply an element necessary for these processes. Having got rid of the oxygen, the hæmoglobin then unites with the carbonic acid produced by tissue disintegration, and the corpuscles thus reladen carry their burden back to the lungs, and discharge there the carbonic acid, taking up a new supply of oxygen. If the hæmoglobin of the blood fall below a certain standard, the supply of oxygen necessary to healthy tissue changes in brain, nerve, muscle, etc., becomes too limited, and the changes will be imperfectly performed; hence defective vitality, general or local. Now the ingestion of iron increases the hæmoglobin supply when it is defective; it promotes the production of blood corpuscles, and causes each corpuscle to carry with it more hæmoglobin; hence the health-giving power possessed by this metal. The exact method in which the increase in red coloring matter is brought about we do not know, but in the fact that iron forms an essential constituent of hæmoglobin we have some clew to its utility. All this was recently ascertained.

ROBERT FULTON.

[Born 1765. Died 1815.]

Successful application of steam to navigation is unquestionably due to the persevering efforts of ert Fulton; because, while Fitch and others had the same idea that he had, and were pursuing it eir own way, he outstripped them in the race by superior genius. Many had already tried and d where Fulton at last succeeded, so that the world gives no more than its just reward to his patient unremitting labors when it places Robert Fulton's name upon the roll of benefactors, "not for an but for all time."

CHAPTER IV.

STEAM.

ITS EARLIEST USES—THE STEAM ENGINE—JAMES WATT—STEAM NAVIGATION—ROBERT FULTON—THE "CLERMONT"—THE SCREW PROPELLER—INVENTION OF THE LOCOMOTIVE—THE SLEEPING CAR—THE AIRBRAKE.

COAL, iron and steam are the three co-operative powers of modern civilization. The possible utility of steam as a motive power seems to have long been dreamed of by thinking minds. In the sixteenth century men were already perceiving that it might be made a potent energy in serving man in the realm of mechanics. Cardan, in the middle of the century, wrote of what might be wrought by creating a vacuum by the condensation of steam, and Matthesius spoke of the "tremendous results which may follow the volcanic action of a small quantity of confined vapor." Other thinkers theorized on the subject, but it was not until 1663 that the capacity of the imprisoned giant seems to have been clearly seen. At that time the Marquis of Worcester published his "Century," describing a hundred of his own inventions. Among them was the real germ of the steam-engine, "a forcible way to drive up water by fire," which he is said to have invented after watching the pot-lid waltz above boiling water. He applied his discovery to raise water out of mines, and is undoubtedly entitled to the credit of producing the first—though crude—steam-engine ever constructed.

Others followed him with more or less success, among them Denys Papin (1647-1712), a most versatile genius, who declared that steam would become a universal motive power, and who described a steamer propelled by paddles, and constructed one, the successful operation of which is not reported, so so that we may conclude that it was like many other inventions that "would not work." Thomas Savery (born 1650) made great improvements on the machines of his predecessors, and Thomas Newcomen, about 1700, added the safety-valve, automatic valve motion, and other improvements, so that his engines were employed in draining mines that had become valueless by reason of water; also for water-works, draining marshes, etc. But the cost of fuel was very great, so that the engine could not be used profitably. But in Newcomen's engine the real work was done by the pressure of the atmosphere, and not by the force of the steam. Nevertheless, all these and other thinkers had laid the foundation on which the genuine steam-engine could be built, and its

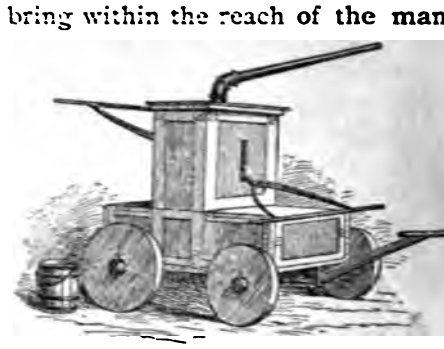
successful architect came with the advent of James Watt, who belongs to the century in which he spent nearly a score of the years of his life. He made such improvements

STEPHENSON'S LOCOMOTIVE, "THE ROCKET."

as revolutionized the steam-engine, and added such original features as rendered the whole structure practically an original invention. He was in fact the real inventor of the successful steam-engine, though he found its foundation in Newcomen's atmospheric engine.

His attention was first drawn to the defects of the engines in use. The great waste of heat, three-fourths of which was not utilized, led him to cover boiler and pipes with poor conductors of heat. He added a second head to the cylinder, and worked the rod of the piston through a box which excluded the air and prevented the cooling of the piston at each descent. These inventions have scarcely been improved since. Watt also introduced the rotary ball governor, the steam indicator and regulator, packing the piston with lubricant, and many other features that added to the excellence of the steam-engine. He also added rotary motion and the crank, and invented the double-action engine, the coupled engine, the rotary engine, or steam-wheel, the throttle-valve, the mercury gauge—in fact, most of the features of the modern machine originated in his fertile brain.

The vast accomplishments of the century in manufactures produced by steam, which have brought the necessities and luxuries of life within the reach of common people, are to be credited largely to James Watt. A hundred years ago cotton cloth cost fourfold its present price; calico that now is sold at three or four cents a yard was a quarter-dollar; and while the commodities are thus reduced in cost to the consumer, their manufacture now employs scores of workers for every one then. Among the physical benefactors of the race Watt should be placed in the front rank, for he not only opened a multitude of avenues for the employment of human labor, but he also contrived the means of so cheapening commodities as to bring within the reach of the many



FIRE-ENGINE OF A CENTURY AGO.

those comforts that would, but for him, have been possible only to the few. The steam-engine was first applied to cotton manufacture, which at once received a great impetus. It

had so increased in the United States, as to use, in 1815, more than 27,000,000 pounds of cotton, employing 350,000 spindles; in 1896 nearly 1,300,000,000 pounds were used, employing nearly 17,000,000 spindles. Similar progress has been made in other textile manufactures. So great has been the increase in the number employed in manufactures in this country that, in 1890, 4,700,000 persons, one-fifteenth of the total population, were so employed.

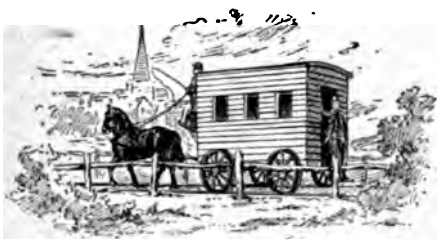
James Watt was born in Greenock, Scotland, January 19, 1736, and died August 25, 1819. He early developed mechanical ingenuity. At eighteen he began to learn to make mathematical instruments, in Glasgow, but soon went to London. In 1761 he returned to Glasgow, and became interested in steam and steam machinery. Besides his steam inventions, already referred to, he invented a micrometer. He was the first to apply steam to the warming of houses. He invented the letter-copying press, a flexible iron pipe with ball and socket joints for the purpose of carrying water across the Clyde, the flexibility being designed to fit the pipe to the inequalities of the bed of the river.

His statue by Chantry is in Westminster Abbey, a grand and imposing presence, on the pedestal of which are these words: "Not to perpetuate a name, which must endure while the peaceful arts flourish, but to show that mankind have learned to honor those who best deserve their gratitude, the King, his Ministers, and many of his nobles and commoners of the realm, raised this monument up to James Watt, who, directing the force of an original genius, early exercised in philosophical research, to the improvement of the steam-engine, enlarged the resources of his country, increased the power of man, and rose to an eminent place among the most illustrious followers of science and the real benefactors of the world. Born at Greenock, MDCCXXXVI. Died at Heathfield, in Staffordshire, MDCCCXIX."

The perfected steam-engine is emphatically the child of the Nineteenth Century.

Watt could not help inventing: new contrivances continued to be the pastime of his leisure hours; and thus to his irrepressible genius for mechanism were due the machine for copying letters, the instrument for measuring the specific gravity of fluids, his regulator lamp, his machine for drying linen, and other machines elsewhere mentioned. He had the usual trials of inventors. Attempts to pirate his inventions sharpened his distresses. Ordinary mechanicians made their fortunes by these despicable means. It had been so during life; his drawing machine, his microscope, his crank, had been appropriated and purloined, and the same fate threatened the condensing-engine on which he had bestowed twenty years of toil. The Cornish miners, with the most selfish dishonesty, sought to evade the payments which they had stipulated. Thousands of pounds had to be spent to vindicate the rights of patentees; and though invariably successful, the anxiety these legal

processes caused to Watt's too sensitive mind were such as can be imagined only by those who have been drawn against their will within the whirlpool of law courts. Notwithstanding all his troubles and trials



THE FIRST RAILROAD CAR.

Watt lived to old age, and enjoyed a remarkable exemption from the infirmities usually incident to it. Until eighty-three years old he went daily into his workshop after answering letters, and was often seen in the company of the men of the day most illustrious in literature and science. Scarcely a subject could be started in which he was not at home, and wherever he went he proved a center of attraction. Even little children thronged around him. We stand amazed at the enormous results of the activity of a single mind, when we cast our eye over a railway map and think of the impetus his invention has given to the life of the civilized world.

There was very little mechanical skill a hundred years ago. The great mechanician Fairbairn says that then "the human hand performed all the work that was done, and performed it badly. James Watt was nearly baffled in getting the first model of his engine made. His cylinder could not be bored; it could only be rudely shaped out under the hammer, and it leaked so abominably that steam could scarcely be kept out of the engine. The roughly-fitted machine emitted a 'horrible noise' as it moved. But the great inventions of the day called imperiously for more perfect tools and higher excellence of mechanical execution. Nor did they call in vain. In due time there came a race of great mechanicians, whose task it was to create a suitable embodiment for the conceptions of the inventors. Bramah of the patent lock was the first to construct machines for working in iron. He could not, without such help, attain the requisite precision in making the parts of his lock. One of his pupils was Maudslay, who devised the fixed slide-rest. Another was Clements, who made the first planing-machine. Nasmyth followed with his steam-hammer. Whitworth raised incalculably the standard of mechanical precision by inventing a machine which detects variations of the one-millionth part of an inch. Innumerable contrivances fol-

THE FIRST RAILROAD TRAIN IN AMERICA.

lowed for shortening processes of labor and obtaining accurate results. In half a century a vast, although comparatively unnoticed, revolution had been accomplished. Machinery had superseded the human

A VESTIBULE TRAIN.

"The perfected steam-engine is emphatically the child of the nineteenth century."

AN OCEAN LINER.

"Steam is found in triumphant operation on the seas."

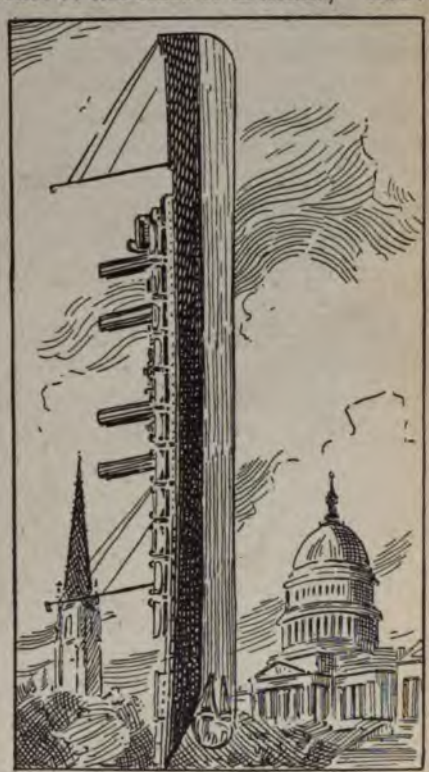
hand. The workman was no longer the maker of any piece of work. He was merely the director of a machine."

The multitude of improvements in steam boilers and their accesso-

FULTON'S STEAMBOAT, "THE CLERMONT."

ries, that have illustrated human ingenuity, cannot here be even hinted at.

Though the days of steam now seem to be numbered, and electricity is taking up human progress where steam must leave off, as man's "hewer of wood and drawer of water," it is none the less true that no other invention or discovery has so contributed to the progress of the race as the steam-engine. Even as long ago as 1828 Daniel Webster (1782-1852) used language that could be emphasized to-day: "In comparison with the past, what centuries of improvement has this single agent comprised in the short compass of fifty years! Everywhere practicable, everywhere efficient, it has an arm a thousand times stronger than Hercules, and to which human ingenuity is capable of fitting a thousand times as many hands as belonged to Briareus. Steam is found in triumphant operation on the seas; and under the influence of its strong propulsion the gallant ship still steadies with an upright keel against wind and tide. It is on the rivers, and the boatman may repose on his oars; it is on the highways, and exerts itself along the courses of land conveyance; it is in the bottom of mines a thousand feet below the earth's surface; it is in the mill and in the workshops of the trades. It rows, it pumps, it excavates, it carries, it draws, it lifts, it hammers, it spins, it weaves, it prints; it seems to say to men, at least to the class of artisans, 'Leave



COMPARATIVE LENGTH OF A MODERN STEAMSHIP.

off your manual labor, give over your bodily toil; bestow but your skill and reason to the directing of my power, and I will bear the toil—with no muscle to grow weary, no nerve to relax, no breast to feel

faintness.' If its power were now to be annihilated, if we were to miss it on the water and in the mills, it would seem as if we were going back to rude ages."

And yet what Webster saw in 1828 was but a shadow of what has since been seen of the triumph of steam—for it has been applied to every kind of labor, and to all locomotion on land and sea. Land carriages were suggested by Gurney, Anderson, Scott, Russell and Hancock, and were coming into general use when the advent of the railway superseded them. And now the electric motor on tramways, railways, and even on the highway, and petroleum as a motor, are fast supplanting the horse and steam. These and the bicycle are revolutionizing travel as we write.

Portable engines for all mechanical purposes, are among the great labor-saving resorts of the age. In agriculture, the mechanical arts, for forest-felling, fire engines, road-rollers, etc., machines are everywhere moved by steam, gas, or electricity, performing the most herculean tasks, where but a few years ago human muscle was the only motive power known.

In 1835 Humphrey invented the "trunk steam engine."

In this country, Oliver Evans, in 1804, offered to build for the Lancaster (Pennsylvania) Turnpike Company a steam carriage to carry a hundred barrels of flour fifty miles in twenty-four hours. He built a steam carriage in 1805, propelled by a paddle-wheel at the stern. This was the first steam carriage in America. Oliver Evans' high pressure engine was a complete success in 1803; Stephens' multitubular boiler came in 1800-7, patented in England in 1805. At first steam boilers were heated from the outside, like kettles. Evans, in 1804, constructed the first flue boilers. Trevethick put the first flue in a locomotive in 1802-1805.

STEAM NAVIGATION.—Steam was utilized in moving machinery on land long before it was employed in navigation or in locomotion. The idea occurred to the Marquis of Worcester, and to other ingenious minds in England, France, Geneva and the United States all through the eighteenth century. Denys Papin (1647-1714), early in the eighteenth century, had a very clumsy scheme. It was to raise water by means of a steam engine in the boat, and let it fall on paddles, and thus navigate the craft. Such a vessel could scarcely resemble Holmes' steamer and "walk the waters like a thing of life," except that it could no more than "walk." As long ago as 1707 Papin navigated a boat down the Fulda. William Henry, in Pennsylvania, built some sort of a craft which was sunk in the Conestoga river. The Marquis de Gouffroy, in France, in 1781, made a rude steamer which sailed on the Saone. James Rumsey (1743-1792), of Virginia, built a craft which actually moved at the rate of four miles an hour. Water was drawn in at the bow and discharged at the stern. Others attempted the solution of the problem. Dr. Benjamin Franklin (1706-1790) paid much attention to it, and submitted a plan to the Phil-

adelphia Philosophical society, in 1785, substantially like others that had not succeeded, namely, driving the water through the boat from stem to stern.

The first to give to the conception of steam navigation a practical and practicable materialization was John Fitch (1743-1798), born in Hartford, Conn. In the records of the American Philosophical Society, of Philadelphia, it is recorded, September 27, 1785: "The model, with a drawing and description, of a machine for working a boat against the stream, by means of a steam engine, was laid before the society by Mr. John Fitch," and in December of the same year: "a copy of the drawing and description of a machine for rowing a boat against the current, which some time ago was laid before the society by Mr. John Fitch, he, this evening, presented to them." In July, 1786, Fitch's boat, with oars moved by steam, was built, but it was not until August 22, 1787, that the craft was tested. "The cylinder was only twelve inches in diameter, and the force of the machinery was not sufficient to move the boat at a rate of speed which would render it valuable for use on the Delaware as a packet-boat."

In July, 1788, and June, 1790, an improved boat was tried, and during the latter year it seems to have made regular trips on the Delaware river from June 14th to September 10th. But the inventor's disappointments destroyed his mind, and he suicided in Bardstown, Kentucky, in July, 1798. He undoubtedly constructed the first successful steamboat ever built. To what extent Fitch was indebted to the French inventors we are not informed, but that his models were original there is not the least doubt. In the first he employed a large pipe kettle for generating the steam, the motive power being side paddles, working after the fashion of oars in a common rowboat. In the second Fitch craft the same mode of propulsion was adopted, with the exception that the paddles were made to imitate a revolving wheel and were fixed to the stern—clearly foreshadowing the present sternwheelers. This last mentioned boat was the first American steam vessel that can be pronounced successful. It made its first trip to Burlington in July, 1788.

While Fitch's experiments were progressing other inventors were at work; Rumsey in this country, and Patrick Miller (in 1786-7) in England, and William Symmington (1788) in the same country. In 1788 Nathan Read (1759-1849), in 1789 Oliver Evans of Philadelphia, in 1790 Samuel Morey of Oxford, New Hampshire, in 1792 Elijah Ormebee of Rhode Island, and others were busy making progress in realizing what was evidently "bound to come."

But it was not until the "Century of Centuries" came in that the first continuous success was achieved. In 1801 William Symmington built for Lord Dundas what the English claim was the first successful steamboat ever constructed, the "Charlotte Dundas." It was a stern-wheeler, propelled by Watts's steam engine. It seems to have been successfully

used for a while as a towboat, but it could not have been completely satisfactory, for it was abandoned and no further attempts were made to produce others until after Fulton's boat solved the steamboat problem.

Meanwhile, in 1804, John Stevens of Hoboken, constructed a "propeller," with twin screws, whose principle seems to have been sound, but which must have had at least one "screw loose," as it was not long used. The idea had been partially worked out by Hooke (1680), Dagnet (1727), Pancton (1780), Bramah (1784), Fulton (1794), Cortwright (1798) and Shorter (1802).

Robert Fulton (1765-1815) appears to have studied the subject of steam navigation thoroughly, and to have been competent to perceive all the advantages and defects of his predecessors. He was born in Pennsylvania, the son of an Irish tailor, who had migrated to this country when a boy. The son was full of invention in early youth, and at the age of twenty-one had saved money sufficient to purchase a small farm for his widowed mother, whose husband had died when Robert was three years of age; and as he had developed ability as an artist he went to Europe to study art under Benjamin West. But his genius for invention was irrepressible, and he substituted mechanical engineering for art, and soon began to wrestle with the problem of steam navigation. In 1793 he wrote to the Earl of Stanhope that he had the principles of an invention which would move ships by steam. During his residence in London he received patents for a process of sawing marble, for spinning flax, for ropemaking and for canal excavation. Here, too, he became acquainted with Watt. In 1797 he removed to Paris and turned his attention to the construction of submarine arms. His success may here be briefly recorded.

"On the 3d of July, 1801, he embarked, with three companions, on board his plunging boat in the harbor of Brest, and descended in it to a depth of five, ten, fifteen, and so on to twenty-five feet; but he did not attempt to go lower, because he found that his imperfect machine would not bear the pressure of a greater depth. He remained below the surface one hour. During the time they were in utter darkness. Afterward he descended with candles, but finding a great disadvantage from their consumption of vital air, he caused, previously to his next experiment, a small window of thick glass to be made near the bow of his boat, and he again descended with her on the 24th of July, 1801. He found that he received from his window, or rather aperture, covered with glass, for it was no more than an inch and a half in diameter, sufficient light to enable him to count the minutes on his watch. Having satisfied himself that he could have sufficient light when under water; that he could do without a supply of fresh air for a considerable time; that he could descend to any depth, and rise to the surface with equal facility, his next object was to try her movements, as well on the surface as beneath it. On the 26th of July he weighed his anchor and hoisted his sails; his boat

had one mast, a mainsail and a jib. There was only a light breeze, and therefore she did not move on the surface at more than the rate of two miles an hour; but it was found that she would tack and steer, and sail on

ROBERT FULTON.

a wind or before it, as well as any common sailing-boat. He then struck her masts and sails; to do which and to perfectly prepare the boat for plunging, required about two minutes. Having plunged to a certain depth and found that with the exertion of one hand only, he could keep her at any depth he pleased, the propelling engine was then put in motion, and he found that on coming to the surface he had, in about seven minutes, made a progress of 400 metres, or 500 yards. He then again plunged, turned her around while under the water, and returned to near the place he began to move from. He repeated his experiments several days successively, until he became familiar with the operation of the machinery and the movements of the boat. He found that she was as obedient to her helm under water as any boat could be on the surface, and that the magnetic needle traversed as well in one place as in the other. On the 7th of August, Fulton again descended with a store of atmospheric air compressed into a copper globe of a cubic foot capacity, into which 200 atmospheres were forced. Thus prepared, he descended with three companions to the depth of five feet. At the expiration of an hour and forty minutes he began to take small supplies of pure air from his reservoir, and did so, as he found occasion, for four hours and twenty minutes. At the expiration of the time he came to the surface without having experienced any inconvenience from having been so long under the water." Very little improvement in submarine navigation has been made on Fulton's original construction.

THE FIRST STEAMSHIP.

In 1802 Fulton and Robert R. Livingston (1746-1813) began in Paris those investigations which were to result in the successful steamboat. The paddles, or oars, suggested by Fitch were discarded; also a sort of duck's feet that should open as pushed out, and shut as drawn in;

also the plan of forcing water out of the stern. Fulton employed at first endless chains with paddle-boards, and finally the paddle-wheel. The boat was completed in July, 1803, and moved tolerably well, but not to Fulton's satisfaction. In 1806 Fulton returned to his native land, and from that time he seems to have devoted his energies exclusively to steam navigation. In 1798 the legislature of New York had bestowed upon Chancellor Livingston the sole right to navigate all boats propelled by fire or steam, on condition that he should produce a boat thus navigated within a year, that should move at least four miles an hour. He went to France as Ambassador, and while there formed a partnership with Fulton to further the scheme in which Livingston was intensely interested. In 1802 and 1803 Fulton constructed models, the first moved by endless chains and resisting boards, and in the latter year, one with a wheel. It was a failure, but it was repaired, and in July it made a successful trial on the Seine. It did not fully meet the anticipations of the inventor, but he saw his way clearly, and at once ordered machinery sent to America. In the meantime Livingston had his option extended in New York, and Fulton went to his native land and began to build a boat. In the spring of 1807 it was launched on the East river. It was the "Clermont," the first practical steamboat, and from that day there has been no cessation in steam navigation. The first trip was made to Albany. The Clermont was 133 feet long, seven feet deep, eighteen broad, 160 tons; one cylinder two feet in diameter, four feet stroke; paddle and wheels fifteen feet diameter, two feet dip, four feet broad; boiler twenty feet long, seven feet deep, eight broad. It moved at the rate of five miles an hour. "She had the most terrific appearance from other vessels which were navigating the river, when she was making her passage. The first steamboats used dry pine for fuel, which sends forth a column of ignited vapor many feet above the flue, and whenever the fire is stirred a galaxy of sparks flies off, and in the night have a very beautiful and brilliant appearance. This uncommon light first attracted the attention of the crews of other vessels. Notwithstanding the wind and tide were adverse to its approach, they saw with astonishment that it was coming rapidly toward them; and when it came so near that the noise of the machinery and paddles was heard the crews (if what was said in the newspapers be true) in some instances shrunk beneath the decks from the terrific sight, and left the vessels to go ashore, while others prostrated themselves and besought Providence to protect them from the approach of the horrible monster, which was marching on the tides and lighting its path by the fires it vomited." It is said that at the first attempt the crank broke, and the crowd dispersed laughing at the explosion of another humbug.

The passage of the "Clermont" up the Hudson was a triumphal progress. Multitudes flocked to the shores to see this strange craft

moving steadily on without the help of wind or sails. In thirty hours she had steamed the 150 miles to Albany without meeting with the least accident. With modest triumph Fulton records that the "Clermont" had overtaken the various sailing craft, and had passed them as if they had been at anchor. The following letter gives too concisely his own account of the voyage:

New York, Aug. 20.

To the Editor of the "American Citizen:"

Sir,—I arrived this afternoon at four o'clock, in the steam boat from Albany. As the success of my experiment gives me great hope that such boats may be rendered of much importance to my country, to prevent erroneous opinions and give some satisfaction to the friends of useful improvements, you will have the goodness to publish the following statement of facts: I left New York on Monday, one o'clock, and arrived at Clermont, the seat of Chancellor Livingston, at one o'clock on Tuesday, time twenty-four hours, distance 110 miles. On Wednesday I departed from the Chancellor's at nine in the morning, and arrived at Albany at five in the afternoon, distance forty miles, time eight hours; the sum of this is 150 miles in thirty-two hours, equal to near five miles an hour. On Thursday, at nine o'clock in the morning, I left Albany and arrived at the Chancellor's at six in the evening; I started from there at seven and arrived at New York on Friday at four in the afternoon, time thirty hours, space run through 150 miles—equal to five miles an hour. Throughout the whole way, my going and returning, the wind was ahead; no advantage could be drawn from my sails—the whole has, therefore, been performed by the power of the steam engine.

I am, sir, your most obedient

Robert Fulton.

The first steam war vessel was "Fulton the First," whose keel was laid in 1814, in New York. She voyaged to the ocean and back, fifty-three miles, in eight hours and fifty-three minutes.

Fulton had built ten other steamboats before the year 1813, after which he devoted his energies to the submarine battery, for which he received a patent that year. He died February 24, 1815, from a cold contracted, a few days before, in New Jersey, where he went as a witness before the legislature to procure the abrogation of a law forbidding a ferry boat between New York and New Jersey.

If Fulton did not entirely invent, he created, the steamboat, by rejecting the errors of his predecessors, and combining all their valuable discoveries with his own inventions and improvements.

In 1811, four years after the "Clermont" demonstrated the arrival of the new era, Henry Bell launched the "Comet" in Great Britain. In 1817 there were seven steamboats on the Thames, and a parliamentary commission of that year pleads the necessity of a further use of steam, and refers to this country, saying, that we preceded by "some years" steamboat navigation "in any part of Europe."

The navigation of the ocean soon followed river navigation. In 1818 the "Savannah," a vessel of 350 tons, purchased in New York by Mr. Scarborough, of Savannah, made the first ocean voyage ever made, and in May she crossed to Liverpool in twenty-two days. The Savannah used steam only occasionally. The first voyage entirely by steam, was made by the "Sirius," in 1838, when two English vessels, the "Sirius" and the "Great Western," crossed from Bristol, England, to New York, the former in nineteen, and the latter in eighteen days. The first steam voyage to India was made by Captain Johnson, in the Enterprise, in 1825. In 1845 the "Great Britain" did the distance from New York in fourteen days, more than double the time now taken by fast liners. When steam navigation was first proposed, Sir Joseph Banks, President of the Royal Society, said: "It is a pretty plan, but there is just one point overlooked—that the steam engine requires a firm basis on which to work." "Ah, my dear friend," said Admiral Sir Isaac Coffin, in 1839, to Vincent Nolte, taking his hand kindly, "if you esteem your life, give up the thought of taking passage in the 'Great Western.' She has had the good fortune to make one summer transatlantic voyage, but in autumn and winter it is risk of human life to sail in her. She may succeed once or twice, but in heavy winter storms no steamer can scud. Be sure of that!" It is a curious fact that the celebrated Dr. Dionysius Lardner declared that oceanic steam navigation could never be successful, because it would be impossible for a ship to carry coal enough to last her across the ocean. Within thirty days of the utterance of the prophecy a steamer crossed the Atlantic, and, in fact, brought to America the first copies of Doctor Lardner's book proving that a successful ocean steamship was an impossibility! Fifty years ago a voyage of thirteen days in crossing the Atlantic was considered a remarkable performance. The list given below is a record of the ocean "greyhound" from the Great Western in 1839, to the Lucania and Campania in October, 1893: 1839, Great Western, Liverpool to New York, 18 days; 1845, Britannia, Liverpool to New York, 14 days; 1848, Europa, Liverpool to New York, 11 days, 3 hrs.; 1852, Baltic, Liverpool to New York, 9 days, 19 hrs.; 1864, Scotia, Queenstown to New York, 8 days, 15 hrs., 45 min.; 1867, City of Paris, Queenstown to New York, 8 days, 3 hrs., 11 min.; 1869, City of Brussels, New York to Queenstown, 7 days, 18 hrs., 2 min.; 1879, Arizona, Queenstown to New York, 7 days, 9 hrs., 23 min.; 1882, Alaska, Queenstown to New York, 6 days, 22 hrs., 10 min.; 1885, Etruria, Queenstown to New York, 6 days, 5 hrs., 45 min.; 1887, Umbria, Queenstown to New York, 6 days, 4 hrs., 42 min.; 1888, Etruria, Queenstown to New York, 6 days, 1 hr., 55 min.; 1889, City of Paris, Queenstown to New York, 5 days, 23 hrs., 27 min.; 1890, Teutonic, Queenstown to New York, 5 days, 18 hrs., 27 min.; 1891, Teutonic, Queenstown to New York, 5 days, 16 hrs., 31 min.; 1892, City of Paris,

AN OVERLAND STAGE COACH.

"The Forty-niners occupied five months in reaching the Pacific coast; the same distance is now accomplished in three days."

LUXURIES OF MODERN TRAVEL.

Queenstown to New York, 5 days, 14 hrs., 24 min.; 1893, Lucania, New York to Queenstown, 5 days, 13 hrs., 30 min.; 1893, Campania, Queenstown to New York, 5 days, 13 hrs., 23 min.

The largest steamship ever constructed was the Great Eastern, 680 feet long, eighty-three feet beam, 18,500 tons, coal capacity 12,000 tons, with accommodations for 4,000 passengers. She cost $3,720,000. The greatest power indicated by paddle engines was 5,000, on the Great Eastern. The greatest power indicated by single screw engine has been on the Etruria, 14,500. The steamers Paris, New York, Teutonic, and Majestic were the first vessels built for the Atlantic service with triple expansion engines and twin screws. The Campania and Lucania are respectively the fifteenth and sixteenth twin screw vessels of more than 6,000 tons. The Servia was the first mail steamer in the New York trade to be built of steel.

During sixty years the Cunard line has conveyed millions of passengers, and not a single life of them all has been lost—a record of safety of travel that no other method of transportation can equal.

The great fleets of steamers have reduced the transit, from the British Isles to this country, from an average of forty days to little more than one-eighth of that time. This has been accomplished by improvement of form and machinery, and change of mode of propulsion from side-wheels to screws. The diminution of the time and its regularity have resulted in great diminution of cost; and the total number of immigrants to this country since 1838 appears to be seventeen millions, but little short of the present population of Brazil or Spain—one and a half times that of Mexico—twice that of Scotland and Ireland combined—equal to that of the United States in 1840—equal to the combined population of the States of New York, Pennsylvania, Ohio, and Michigan in 1890.

The Whaleback is a new form of steam vessel, invented by Capt. Alexander McDougall, of West Superior, Wisconsin, in 1874. The name whaleback was suggested by the resemblance of the visible portions of the vessel, when afloat, to the back of the whale. Captain McDougall's idea was to build a vessel of steel with top-sides and erections rounded in such form as would reduce the resistance to both wind and water to a minimum.

The steamboat in all its forms is, of course, an achievement of the Nineteenth Century.

James Watt seems to have had the idea of the screw, in 1770; it was revived by Joseph Bramah in 1785. Joseph Ressel, in Austria, 1794, patented the idea; also Lyttleton in 1794, E. Shorter in 1799. J. C. Stevens, Hoboken, in 1804, built the first twin screws; Henry James in 1811, Richard Trevethick in 1815, John Swan in 1824, Robert Wilson in 1827, Francis Pettit Smith in 1834 (who patented the idea in 1836), and others made improvements. The last-named seems to have made the screw practical to some extent. In 1855 George Rennie, England, constructed a boat with twin screws; in

1851 Captain Carpenter also; but in 1837 its practicability was demonstrated by the American inventor, Capt. John Ericsson (1803-1889),

JAMES WATT.

since which time the screw has steadily gained in favor as a means of propulsion for vessels all over the world. Ericsson "accomplished for steam propellers what Fulton wrought for the paddle-wheel." In 1860 Messrs. Dudgeon, of London, England, constructed a steamer with twin screws, one under each quarter, having independent action, and imparting additional steering power.

Macaulay, in eulogizing steam, exulted that it propelled ships ten knots an hour against the wind. Already nearly, or quite thirty knots, are accomplished. And it is true now as he said it was then, "Its law is progress; a point which yesterday was invisible is its goal to-day, and will be its starting point to-morrow."

A great impetus was given to steam navigation when iron and steel were substituted for wood. An iron ship of the same size is lighter and more buoyant than a wooden one. An iron vessel was launched in July, 1787, by John Wilkinson, England, but not another was built until 1810, when Onions & Son, England, launched several. In 1815 Jevons, of Liverpool, and in 1821 Aaron Manby, launched iron vessels. It was not until the end of the first quarter of the century that the practice came to be general.

The following synopsis is interesting: The first idea of the steamboat was patented in England in 1736 by Hulls; Fitch experimented on the Delaware river in 1783-4; Oliver Evans tried steam navigation in 1785-6; Ramsey attempted it in Virginia in 1787; W. Symmington on the Forth and the Clyde in 1789; Chancellor Livingston built a steam-

RICHARD TREVETHICK.

er on the Hudson in 1797; the first steamboating on the Thames, 1801; Symmington repeated his experiments on the Thames successfully,

1802; Fulton built his steamer and sailed from New York to Albany in thirty-three hours in 1807. His next boat was the Car of Neptune in 1808; he built the "Neptune" at Pittsburg, the first steamer on western waters, and made the voyage to New Orleans, 2,000 miles. In 1811 the "Paragon" was built; the "Richmond" in New York in 1812; the "Vesuvius" was built at Pittsburg in 1813. First steam vessels in Scotland in 1813; the first to cross the Atlantic was the "Savannah," 1819, 350 tons; the "Great Western" and "Servia" crossed from Cork to New York in 1838, in eighteen days; the first successful war steamer was built in England, 1838; the first ocean steamer of note was the "Washington," in which this writer crossed to Europe, in July, 1850, fourteen days from New York to Bremen.

Marine engines, triple expansion and triple screw, are wonderful illustrations of mechanical skill. Since 1881 boiler pressure has been increased as high as 200 pounds per square inch.

The son of Lord Rosse, of telescopic fame—C. A. Parsons—has applied the turbine principle (1892) to marine engines, which he invented in 1888. It has produced a speed of thirty-four and a half miles an hour, and may be applied to any machine, and will produce enormous increase of power.

THE LOCOMOTIVE.—The railway and the locomotive are the product of evolution. As early as 1602 wooden timbers were laid for wagons in conveying coal; in 1676 they were so laid that the wheels would keep the track; in 1715 straps of iron were nailed to the wooden rails; in 1767 cast-iron rails were made, and in 1769 an upright flange on rails was introduced. Steel rails were first made in 1857. In 1791 Benjamin Outram, in England, built a railway with convex rails and wheels hollowed to fit them. Hence the word "tram." At first the steam carriage and the railroad were not associated together. The steam carriage was intended for the highway. The first one was invented by Nicholas Cugnot, in Paris, in 1769. It is yet "preserved in the Conservatoire des Arts, et Metiers, in Paris. It has a copper boiler, and two single-acting, thirteen-inch cylinders, which communicate power to a driving-wheel." It was intended to transport artillery. The connection between the engines and the wheel "was effected by means of pawls, as first proposed by Papin, which could be reversed when it was desired to move the machine backward. . . This locomotive was found to have been built on a tolerably satisfactory plan; but the boiler was too small, and the steering apparatus was incapable of handling the carriage." This locomotive may be regarded as the first ever made, though it does not seem to have been used.

In 1759 Robinson suggested steam road carriages, and towards the middle of the eighteenth century road carriages impelled by steam were in common use in England, but they were disused in consequence of their great cost and cumbersome character. In 1784 Watt

patented, but did not build, locomotives. In England, already, engines are employed in lieu of horses far more extensively than in this country. Instead of the farm wagon, that has been a familiar sight on English country roads for so many centuries, we are now treated to the spectacle of a wheezing steam engine, dragging behind it a train of no less than twenty vehicles, loaded with produce for the market. The wheels of the traction engine are so constructed as to enable it to run smoothly even on rough roads. The ponderous wheels are fitted with tires a foot wide, and on these tires sections of steel are bolted crosswise. On a smooth road these specially constructed tires obtain a secure grip, while on a roadway that is rocky and uneven the wheels travel with perfect ease, the transverse sections of steel enabling them to ignore the small obstructions on which the smooth-tired wheel would slip. One of these traction engines recently ran from the farm of George Young, at Swineshead Abbey, to London and back, a distance of 224 miles, dragging a dead weight of fifty-two tons, consuming on the trip only a little more than five tons of coal. This same engine, according to the statement of its owner, does all the work on the farm of 300 acres, besides thus drawing the produce to market.

Symmington, who is referred to in connection with the steamboat, made a road engine the same year as did Hornblower (1769). In 1784 William Murdoch, of Cornwall, England, constructed a steam road carriage. A lamp heated the boiler. It was made to go at the rate of seven miles an hour. In 1787 Oliver Evans (1755-1819), of Philadelphia, patented the right to manufacture steam carriages for roads and railways. His first machine was produced in 1800, but he concluded that it was best adapted to running the machinery of a mill. It was what is known as "double-acting, high-pressure." He is claimed to have originated the high-pressure system. He prophesied the day "when people will travel in stages moved by steam engines from one city to another, almost as fast as birds can fly, fifteen or twenty miles an hour. A carriage will start from Washington in the morning, the passengers will breakfast at Baltimore, dine in Philadelphia, and sup in New York the same day. I have no doubt that my engines will propel boats against the current of the Mississippi, and wagons on turnpike roads, with great profit. Engines will drive boats ten to twelve miles an hour, and there will be hundreds of steamers running on the Mississippi river."

In 1803 a locomotive, produced by Frederic, in Hanover, was operated in a silver-mine, and in 1804 Richard Trevethick (1771-1833) constructed a road locomotive in England. As his work was done after Evans's had been patented in London, it is likely that he obtained his ideas from the latter. The first locomotive was built with teeth in wheels to run in rack-rails. Blenkinsop, in England, in 1811, made and used an engine on a railway track, in a colliery, which drew trains of cars laden with coal for several years. Un-

doubtedly this was the first successful railway engine ever used. The wheels secured traction by working into cogs on the side of the rails. It was not supposed that a smooth wheel would "bite" on a smooth rail. In 1812-13 engines were built with eight wheels. It was then first discovered that smooth wheels would stick to smooth rails. William Hadley's "Puffing Billy" was in use after the middle of the century.

Many other attempts to produce a perfect locomotive were made, more or less successful, though all were defective, when George Stephenson appeared on the scene. He was born in Wylam, near Newcastle-on-Tyne, on June 9, 1781, and died in 1848, after seeing the world revolutionized largely through his inventive genius. He was born among the poorest of the poor, and began a life of toil in the colliery in which his father was employed. At eighteen years of age he could neither read nor write. He took night lessons of a neighboring schoolmaster, and at nineteen was working as brakeman of an expensive pump, which would not work, and which none of the mechanics could make operate. Young Stephenson declared he could perfect the pump, and having received permission to do so, he took the machine to pieces, and in four days he had it in fine running order, and in two days more he had pumped the mine dry. He was presented with ten pounds for his work, and elevated to the post of engineer. In 1813 he saw the engine invented by Blenkinsop and observed that he could construct a better one, and in 1814 he set his invention on the Killingworth railroad, where it drew eight loaded cars at the rate of four miles an hour, on a steep gradient. But not proving economical on account of the great consumption of fuel, in 1815 he added the steam-blast, and the connection and joint action with the wheels by horizontal bars on the outside. Previous to this, improvement had been very slow. He continued improving the locomotive and railway tracks until 1825, when the first railway in the world was opened—that from Stockton to Darlington (September 25, 1825), the second, that from Liverpool to Manchester (September 15, 1830). The managers of the road insisted that it could only be operated successfully by stationary engines, and Stephenson, after much opposition, induced them to offer a prize for the best locomotive. He carried his point after the fiercest opposition. It will amuse the reader of to-day to learn how the advent of the locomotive was regarded. A leading newspaper said that the locomotive would prevent cows from grazing and hens from laying. The poisoned air from the locomotives would kill birds as they flew over them, and render the preservation of pheasants and foxes no longer possible. Householders adjoining the projected line were told that their houses would be burned by the fire thrown from the engine chimneys, while the air around would be polluted by the clouds of smoke. There would no longer be any use for horses; and if the railways extended, the species would become extinguished and oats and hay unsal-

able commodities. Traveling by road would become rendered highly dangerous, and country inns would be ruined. Boilers would burst and blow passengers to atoms. But there was always the consolation to wind up with—that the weight of the locomotive would completely prevent its moving, and that railways, even if made, could never be worked by steam power. Even the great "Quarterly Review," March, 1825, declared: "The gross exaggerations of the powers of the locomotive engine, or, to speak in plain English, the steam-carriage, may delude for a time, but must end in the mortification of those concerned. . . . What can be more palpably absurd and ridiculous than the prospect held out of locomotives traveling twice as fast as stage-coaches? We should as soon expect the people of Woolwich to suffer themselves to be fired off upon one of Congreve's richochet rockets, as to trust themselves to the mercy of such a machine going at such a rate. We will back old Father Thames against the Woolwich railway for any sum. We trust that Parliament will, in all the railways it may sanction, limit the speed to eight or nine miles an hour, which we entirely agree with Mr. Sylvester, is as great as can be ventured on with safety."

Sir Isaac Coffin, in Parliament, said, in opposition to the Liverpool and Manchester railway, he would not consent "to see widows' premises and their strawberry beds invaded. Railroad trains would take many hours to perform the journey between Liverpool and Manchester, and in the event of the scheme's success, what, he would like to ask, was to be done for all those who had advanced money in making and repairing turnpike roads? What with those who might still wish to travel in their own or hired carriages, after the fashion of their forefathers? What was to become of coach-makers, harness-makers, coach-masters, and coachmen, inn-keepers, horse-breeders and horse-dealers? Was the House aware of the smoke and the noise, the hiss and the whirl, which locomotive engines, passing at the rate of ten or twelve miles an hour, would occasion? Neither the cattle ploughing in the fields, nor grazing in the meadows, could behold them without dismay. Iron would be raised in price 100 per cent., or more probably be exhausted altogether. It would be the greatest nuisance, the most complete disturber of quiet and comfort, in all parts of the kingdom, that the ingenuity of man could invent."

Before the test of Stephenson's locomotive came off the wiseacres asked all sorts of "fool questions." Would not the wheels slip and whirl without moving the train? How could the locomotive get around a curve? What effect would a fast train have on horses? Stephenson answered that the wheels would not slip unless the weight of the load was greater than the power of adhesion to the rail of the wheels; that when the engine came to a curve going at the incredible velocity of twelve miles an hour, it would simply go round it; that horses would soon become accustomed to trains, etc.

And here occurred the incident so often told: "Suppose that one of these engines should be going along at the rate of nine or ten miles an hour, and a cow were to stray on the track, would not that, think you, be a very awkward circumstance?" "Yes," answered the witness, with a twinkle in his eye, "very awkward, indeed—for the coo!" Some of the directors insisted that horses should be the motive power; others that stationary engines—twenty-one for nineteen stations of a mile and one-half each—should move the trains, but on October 6, 1829, the competition came off, and Stephenson's "Rocket" averaged a speed of fifteen miles an hour, and on some parts of the track it achieved nineteen miles.

Stephenson did not hesitate to adopt all the discoveries of his predecessors, such as the multitubular boiler, an American invention, patented by Nathan Read (1759-1849) in 1791, and used with improvements by Robert L. Stevens (1788-1856), of New York, in 1807, both Americans. Wilkie, in his "Great Inventions," says: "Stephenson was great in his self-culture, great in his ingenuity and perseverance, but the greatest of the things which he accomplished was in his waging a conflict, almost single-handed, with all England for the introduction of the locomotive on the Liverpool and Manchester railway. His victory, won after gigantic efforts and against incredible odds, was not merely a personal triumph of the grandest dimensions; it was also a victory of incalculable value to commerce, to labor, and to the world's advancement. It is true that had he not made the fight it would have been made, and would have been won, by some later athlete. The delay might have cost the world ten or even twenty years of its progress; without Stephenson's victory the world might be to-day where it was ten or twenty years ago."

Competent writers have questioned Stephenson's claims, as other locomotives were in the field before his; but success is the test. No doubt the idea was in many minds, and good machines were built by others, even before his. Stephenson's great skill as a workman was invaluable in pushing his claims.

The genealogy of the application of steam to motion, so to speak, may be given in a nutshell. The high-pressure locomotive, Trevethick, 1802; Symmington's steamer side-wheel, 1802; Fulton, steamer, 1802; Evans' steamer dredge, 1803; Wolf, expansion engine, 1804; hot air engine, 1806; Stevens, steamer, 1808; Blenkinsop, locomotive, 1811; Bell, steamer, 1812; Hedley, locomotive, 1812; Dodd, steamer, 1813; Koenig, steam printing press, 1814; Perkins, steam gun, 1824; Stephenson's locomotive, 1824; Naysmith, steam hammer, 1838; Winans, cigar steamer, 1860; Ericsson's Monitor, 1862 (Tymby's turret). The engine has been improved by the reduction of friction and leakage, by jacketing, introduction of tubes, the cut-off, more thorough combustion of coal, the down draft, etc., the work of recent years.

Tramways were first formed towards the end of the last century by

narrow plates of iron, on which iron and coal were drawn by horses. The rails had flanges on the inner edge to keep the wheels on the track. Then edge rails were made, and flanges were built on the wheels. In 1820 the rails were first made of wrought iron, for then malleable iron was first made by rolling. In 1825 the first tramway was built for passengers, the Stockton and Darlington, in England. The carriages were drawn by horses. At that time the principal traffic was by canal. About 1716 it became customary to nail thin plates of malleable iron upon the surface of wooden rails, in order to render them more durable and to lessen the draught of the horses. From this the transition to rails made entirely of iron was easy.

The first public railway was not intended to provide for passenger traffic. The first passenger car was designed by George Stephenson. It could not be entrusted to the tender mercies of a locomotive, but was drawn by a horse. It can only remind us of a "Pullman" by contrast. The outlines of a modern caravan, or bathing machine, are graceful compared with those of the "Experiment." A wooden seat was fixed around the sides of the interior. A deal table was placed longitudinally down the center, on which, when darkness set in, a tallow-candle was placed. The door was at the rear—omnibus fashion. The "Experiment" was drawn by horses, the Stockton and Darlington railway locomotives being reserved for the more important coal traffic. This coach took part in the procession previous to the opening of the railway, October 10, 1825.

"This century owes a vast debt to Stephenson. He gathered the many threads of ingenuity and enterprise, and wove them into that wide-spreading net-work which promises in its manifold extension to envelop the whole world in bonds of commerce, civilization and peace. He was far in advance of his time; and he drew the world up to the point which he had gained. His moral life is likewise of the greatest value on account of its character; it proves that there is no bar to the progress of the poorest, the most humble. Stephenson could have received a title, and he refused it; he is better remembered as the Great Engineer, than he would have been had he been gazetted a prince. What he accomplished is within the reach of all others who have natural ability, backed by industry and perseverance." And yet, not a monument in all Great Britain recognizes his achievements!

When the London underground railway was projected in 1846, "Punch" scoffed at it, saying: "This is a magnificent notion for relieving the over-crowded thoroughfares, and at the same time relieving any particularly over-crowded pocket from its oppressive burden. The prospectus states that the thing 'can be accomplished without any serious engineering difficulties.' The difficulties, instead of being serious, will, we suppose, be merely laughable. If any great dilemma should arise, it will of course be overcome by a little jocularity. We understand

that a survey has already been made, and that many of the inhabitants along the line have expressed their readiness to place their coal-cellars at the disposal of the company. It is believed that much expense may be saved by taking advantage of areas, kitchens, and coal holes already made, through which the trains may run without much inconvenience to the owners, by making a judicious arrangement of the time-table. It will certainly be awkward if a family should be waiting for a scuttle of coals, and should not be able to get it until after the train had gone by; but a little domestic foresight, seconded by railway punctuality, will obviate all annoyances of this kind. Considering the frequent stoppages of the existing thoroughfares the scheme really seems to deserve encouragement. Nothing is wanted, says the prospectus, for this grand undertaking, but public support. If the people will only come down with their money, we should not wonder at seeing the company get as far as half-a dozen advertisements in their daily papers, and a brass plate in the city. Those who are disposed to sink a little capital cannot do better than bury it under the metropolis in the manner proposed.

"We perceive that no amount of deposit is named, and nothing is said of the number or nominal value of the shares. The secretary is announced to be in attendance to receive deposits from eleven to two, though whether he gets any is, in our opinion, ten to one."

The first railway in France was in 1823, used with horses; the locomotive was not employed until 1840.

Railway development in the United States has adapted itself to the needs of a rapidly growing country, a large part of which was first made available for settlement by railways. The first railway worked by horses was in 1826, in Quincy, Massachusetts, a road two miles long. The first locomotive built in this country was made by Col. John Stevens, of Hoboken, in 1825. Three locomotives were imported from England in 1829, and the first trial in America took place on August 8, 1829, at Honesdale, Pennsylvania. The first railway constructed to be worked by locomotives was the South Carolina railroad (1826-30), though trials of an experimental locomotive had been made before on the Baltimore & Ohio railroad, which continued to be worked by horse-power until 1832. The steps in the evolution of the locomotive may be summarized: About 1784 Murdoch made a small high-pressure engine, the flywheels of which, nine and a half inches in diameter, were used as driving-wheels. Trevethick constructed a high-pressure locomotive in 1802, and Blenkinsop and Chapman also made locomotives a few years later. The oldest locomotive in existence, "Puffing Billy," now in the Patent Museum, South Kensington, England, was constructed in 1813, and was continually used until June 6, 1862. In 1814 Stephenson constructed the Killingworth engine, which he continually improved, and, in 1829, won the prize offered by the

directors of the Liverpool and Manchester railway, with his engine, "Rocket." In this he used two cylinders, placed one on each side of the engine, and acting on cranks attached to large driving-wheels. The boiler was traversed by a number of narrow tubes, as proposod by Seguin and Booth. In modern locomotives the boilers are of the tubular form, and the engine is driven by two, or occasionally four, cylinders, placed in front under the boiler, and inside the iron frame on which the boiler is supported. Of course improvements have continually been made, so that the machine seems now practically perfect. And what a change it has wrought in the world! And think of an uneducated mechanic insisting, before any scientist had ever struck the self-evident fact that "the original source of heat is the sun, whose beams furnish the energy that enables vegetables to decompose carbonic acid, and so to form a store of carbon, and of it, combustible compounds, afterward used as fuel. The combination of that fuel with oxygen, in furnaces, produces the state of heat which, being communicated to some fluid, such as water, causes it to exert an augmented pressure, and occupy an increased volume; and these changes are made available for the driving of mechanism." (Rankine's Manual of the Steam Engine.) In America the Baltimore & Ohio railroad was opened in 1830. It was only fourteen miles in length and was operated by horse power, but the next year the company purchased an American locomotive. The first locomotive of American manufacture was placed upon the South Carolina railroad, ten miles long, in December, 1830. There were about 1,000 miles of railroad in the United States in 1836, when the Illinois legislature incorporated the "Galena and Chicago Union," and the construction of the line was not begun till 1847. By the end of that year only 5,205 miles of railroad had been built in the whole United States, the panic of 1837 having paralyzed commercial enterprise for several years.

The discovery of gold in California gave a powerful impetus to the building of railroads east and west, though connection with the Pacific slope was not made till 1869. Chicago was first connected with the east by rail in 1852, so that it is less than a half century since that city began to be a railroad center.

The "Saturday Review" voices the verdict of mankind in saying: "It is not too much to say that the inventor of the locomotive steam engine, and the founder of the railway system of the entire world, has done as much to promote human comfort and advantage as any single man that ever breathed; and more particularly we believe that there is hardly a man, woman, or child in Britain who is not reaping personal profit from the labors of this great and sterling Englishman; from the results of his wonderful ingenuity to devise, and his unparalleled perseverance in urging on his gigantic invention, at a time when great engineers, eminent lawyers and leading members of Parliament were not ashamed to denounce him as an

idiot and to advise his consignment to Bedlam."

For many years American and European railways were railed with strap iron, spiked on wooden timbers. Accidents frequently occurred, caused by "snakes' heads," or the ends of the rails flying up and throwing the cars from the track, or impaling passengers. We believe the Boston and Lowell road was the first in this country to introduce the T rail. This road was first constructed with granite ties. The noise made by the rattling train was something fearful.

The latest improvement in locomotives is called the "Holman," the invention of William J. Holman, of New Jersey, in 1897. At its first formal trial it accomplished 104 miles an hour. Its four drivers are set on two small wheels, and these in turn upon three others, which rest upon the track. They are all propelled by friction and not by cog. It is said that during part of another run a speed of 120 miles an hour, or two miles a minute, was attained. An entire run of 54.1 miles was made in 56.05. The rate of speed for the entire distance was fifty-seven and one-half miles an hour. The engine in this case was equipped with a Holman anti-friction speeding truck, to which the increase in speed was due. The truck is so arranged that it gives to the locomotive a "gear" similar to that of a bicycle, so that it travels for each turn of the drive wheels a distance on the track equal to 1.73 turns.

Another railroad record, broken during 1897, was that between Chicago and Denver. The distance, 1,020 miles, was traveled in eighteen hours and fifty-two minutes. The train that made this remarkable run was a special on the Chicago, Burlington & Quincy. It was chartered in Chicago to carry a gentleman whose son was dying in Denver, and he took the special train method of reaching the boy's bedside at the earliest possible moment. The average speed for the entire trip was a little more than fifty-four miles an hour.

In the infancy of steam traffic passengers paid their fares to the clerk, and walked upon the station platform with their friends until the train arrived; were then conveyed to their destinations, and left the railway without giving any proof to the officials of the station when they disembarked that they had paid their fare at the point of departure. There was, therefore, no check, either upon the clerk who received the money or upon the passengers who paid it. The system now in use was invented about forty-five years ago by Thomas Edmondson, who was then employed at a station on the Newcastle and Carlisle line. The tickets he issued were of about the same size as those now used, but his arrangements for printing them were of the most primitive description. In fact, a few types, fastened together in a case about the size of a nail-brush, formed his sole apparatus. The name of the station to which the passenger was going was written upon the ticket at the time of issue. This system, primitive as it was, grew and flourished, till it became

the parent of the present one. At length the inventor found that it would be desirable to devote himself entirely to the development of the new industry, and by degrees a business arose which became one of the largest of its kind in the world.

From the canal boat and carrier's cart to the locomotive and electric motor seems a long journey. Men had dreamed of the achievement, but it remained for the Nineteenth Century to perfect it.

Mount Washington, New Hampshire, and Pike's Peak, in this country, and other localities in Europe, are ascended by third rail, or cog-wheel steam railways. Mount Echo, California, is ascended by an electric road by an endless cable. (See Professor T. S. C. Lowe.)

Many minor inventions have followed in the wake of the railway. One is the block system, a method of signaling, specially designed to prevent collisions between trains traveling on the same line of rails. The route to be traversed is divided into small sections by telegraph boxes, erected at intervals. Two trains are never for a moment in the same section of the railway, and cannot therefore come into collision.

The "Vestibule System" was devised by George M. Pullman. A great addition to the safety of railway traffic.

Enormous tunnels pierce mountains, miles in extent. The Mons St. Cenis, in Switzerland, is 7½ miles long; the St. Gothard is 9¼ miles long, and many others are marvels of engineering skill. Such is the Great Divide Tunnel, completed in 1893; the Busk-Ivanhoe railway tunnel, under the continental divide of the Rocky mountains, at Hagerman Pass, Colorado. The tunnel is almost two miles long—9,393 feet—and is through solid gray granite. It took three years and twenty days of twenty hours' work each day, to make the excavation. It is 10,800 feet above sea level, through the top side of the continent. The water draining from the one side of the mountain, under which it is driven, runs to the Atlantic Ocean, and from the other to the Pacific. Its construction cost $1,000,000, and twenty human lives. The tunnel substitutes two miles of track for ten, and does away with one of the most expensive railway climbs in the world.

One of the inventions that have contributed to reduce the discomfort of travel to a minimum is the sleeping-car. Its ingenuity of construction and adaptation and luxury of appointment renders it a veritable palace on wheels, and enables the traveler to enjoy comforts *en route* that no occupant of a palace in past centuries ever conceived possible on a journey.

Sleeping-cars were first used on the Erie road. They were built by John Stephenson, under patents granted to Charles McGraw, December 10, 1838. The frames of the seats were constructed so that the cushions could be formed into a sort of couch on which a passenger could rest. No bedclothes or pillows were used. Two of these cars, called the Ontario and Erie, were delivered to the company at Piermont, from the

Stephenson shops at Harlem, New York, in 1843.

In 1858 George M. Pullman (1831-1897) began to evolve the idea of the palace sleeping-car. The sleepers in use at first were copies of the sleeping bunks in the boats on the Erie

A STEAM ROAD-MAKER.

canal. In 1863 he began seriously to work out his problem, and the "Pioneer" was the result. It cost $16,000. This was followed by four others, costing $24,000 each. Now thousands of palace cars convey millions of passengers annually. The palace-hotel-sleeping car system is one of the great achievements of the century. About the same time (in 1862-3) T. T. Woodruff worked on the same problem, and developed a sleeper. But later, Mr. Pullman absorbed the sleeping-car enterprise. So says Andrew Carnegie, who induced Mr. Scott to introduce the Woodruff cars on the Pennsylvania railroad. Mr. Pullman continually improved the car, until it reached its present perfection. Sancho Panza said: "Blest be the man who invented sleep." Next to him should be remembered the man who has rendered long days and nights comfortable, by providing the means of securing the presence of "tired nature's sweet restorer, balmy sleep," as a companion. The invention became a necessity on all railways, and at his death, in October, 1897, his own fortune was $7,000,000, and the Pullman company had capitalized five times the amount. Mr. Pullman, at his death, enrolled his name among those of the world's benefactors by his bequests to benevolent uses.

One of the most remarkable inventions of the century is the Westinghouse air-brake, invented by George Westinghouse, Jr. (1846), in the year 1868. It is an ingenious process of compressing atmospheric air so that it arrests a train almost instantly. It has superseded the old method of hand-braking, and is a most valuable life-saving expedient.

GEORGE M. PULLMAN.

It is related that the inventor first carried his invention to Cornelius Vanderbilt, the railway magnate (1794-1877), who, impatient at what he supposed was another of the fads with which he was frequently annoyed, put off the genius by saying

he had no time to "waste on — fools." Thomas Scott, of the Pennsylvania road, saw the excellence of the new expedient and adopted it. Vanderbilt learned the fact, and wrote to Westinghouse to call when he should be in New York, to which the inventor responded that he had "no time to waste on a—fool who did not know a good thing when he saw it." Mr. Westinghouse had previously invented a steel railroad frog that was very successful. One day he came across a newspaper account of the use of compressed air in piercing the Mount Cenis tunnel. The inspiration seized him, and he applied the principle to car wheels, and the air brake was the result. Few inventions have contributed so much to the safety of travelers. In 1883 Mr. Westinghouse was boring for oil on his grounds, near Pittsburg, Pennsylvania, when, at a depth of 1,560 feet, he struck a vein of natural gas. The result was hundreds of miles of pipe, conveying natural gas to thousands of homes. Mr. Westinghouse is author of a number of useful devices, and is active in exploring the realms of electricity. He spent much time in boyhood in his father's shop, and thus became familiar with machine work. He served in the navy as assistant engineer, and while in the navy invented a multiple cylinder engine in 1865. The same year he invented a device for replacing railroad cars on the track. Delayed one day by a collision on the railway it occurred to him that a brake controlled by the engineer would prevent collision. In 1866 he thought of a steam cylinder under the tender to draw up a chain with a cylinder under each car. In 1868 he made practical use of his brake and in 1869 it was patented. It was first used on the Michigan Central and the Chicago & Northwestern railways. It was fully perfected in 1870. Between 1871 and 1882 he perfected the automatic features; in 1886 the quick action brake, by means of the triple valve. A train of fifty freight cars can be made to feel the brake in two seconds. Scientists unite in regarding the air brake, in its completed form, as one of the most remarkable inventions of the century, and its usefulness is attested by its almost universal adoption by the railroads of the world. Mr. Westinghouse has patented the system of compressed air switches and signals. Through this invention the movement of signals and switches no longer requires considerable physical force, the operations being controlled by tiny levers which a child can move. These plants are splendid illustrations of what can be accomplished by a proper combination of steam, air and electricity. His development of electric lighting and natural gas has been remarkable. The companies manufacturing his inventions represent a capital of $41,000,000, and control 3,000 patents.

The snow or ice locomotive is an engine on runners, moved by steam power, or petroleum, or any of its distillates. It has been in use in the lumber woods of Michigan and Wisconsin, and was proposed to be introduced in 1897 into Alaska, to be employed in transportation where

all other means of traffic would be impossible. George T. Glover, the inventor of the engine, was born in Vermont, in 1849. His parents moved to Saginaw, Michigan, in 1855, when he was six years old. He grew up in the lumber industry in the Saginaw Valley. His youth and early manhood were spent in logging, building sawmills and manufacturing lumber and shingles. Ten years ago he began to study snow traction. He experimented and spent much money and time in his effort to learn the hidden secret and apply it to practical use. He finally succeeded.

The Revolving railroad train threatens to realize its daring conception. It resembles a great Ferris wheel converted into an elevated railroad. Appearance is the only respect in which it looks like the wheel, as its mechanical principle is entirely different. It is built on ball bearings. The great outside rim, or shell, of the train is to all purposes a large wheel, which revolves around the center, this portion of the train remaining stationary. The central part of the revolving train contains the coaches, dining-cars, sleepers, engines, in fact, everything making up the train except the wheels to make it go round. The engines are operated by electricity, which is generated from storage batteries. In this revolving train there are ten separate cars for passengers, exclusive of the compartments for baggage and mail. These ten cars have a carrying capacity of 500 passengers, making an average of fifty people to each car. This train is little less than an immense circular hotel on wheels, and it has all the conveniences that a modern hostelry can boast of. The train is the invention of M. C. Maloney, of Philadelphia. Its speed is 150 miles an hour.

Andrew Carnegie, when fifteen years of age suggested the plan of holding one train, by telegraph, at stations, until another had passed.

Space does not allow more detailed reference to the many inventions that are subordinate to the locomotive, such as Bourdon's steam gauge, that indicates the steam pressure; steam engine governors and cut-offs (Silver's, in 1866); guide-rails and center rails, Neilson's hot-blast (1828), and other collaterals have come in to give perfection to the steam locomotive.

Portable engines are now in use for sawing, threshing, road-making, etc.

The number and variety of car-couplers will illustrate the enormous amount of inventive genius that has been brought to bear on railway operation: Janney, Nos. 1, 2; Standard, Gould, Hinson, Nos. 1, 2; Chicago, Nos. 1, 2; Hammond, Van Dorston, Trojan, Drexel, Smillie, Eureka, Union, Williams, Roberts, St. Louis, Buckeye, California.

H. R. Worthington's steam pump was invented in 1840. Turn-tables, switches, semaphores, block signals, are all operated by steam or electricity. The underground railway was built in London in 1863.

Watt's engines were crude inventions that would make a poor showing beside the wonderful productions of the present time.

Had steam been invented, or the telegraph, the battle of New Orleans would never have been fought—and Jackson would not have been President. Peace had been declared, but sailing ships were weeks in bringing the news.

Express companies were unknown until Wm. F. Harnden (1814-1845) established a line between Boston and New York, out of which have grown the "Adams," "American," "Wells & Fargo," "United States," and others, reaching the remotest corners of the land.

The link-motion, invented by the younger Stephenson, enables the engine to change the direction of rotation, and also furnishes a means by which steam can be employed expansively. Joy's valve-gear, however, has supplanted it, as it leaves the crank axle unencumbered with eccentrics.

Wooden rails were used as early as 1602; flat rails of malleable iron in 1716; cast iron rails in 1767; and until 1820, when malleable iron was substituted. An upright flange was added in 1776; fish bellied in 1805; and the first steel rails were made by Mushet, in 1857. The locomotive that has revolutionized travel and transportation that has broken down geographical and almost political boundaries, is more than almost any other of the factors of civilization and progress, the child of the Nineteenth Century.

The accessories to the steam engine, and locomotive—many of them of the greatest value, and displaying the greatest ingenuity, are hundreds in number. Such as the turn-table, snow-plow, plain and rotary, a most efficient instrumentality in cold countries, car heaters, baggage checks, couplers, etc.

The car wheel has evolved from rude cast iron to a paper wheel which seems perfect.

FIRE ENGINES.—The first rude fire engine was in use in London in 1830. The hose was of leather. Most families owned fire buckets of leather, and when an alarm of fire was sounded all seized their buckets and ran to fight the enemy. In 1840, Hodges constructed a steam fire engine. Before that a square tub, with handbrakes, was used to fight fire.

How well the writer of these lines remembers the old fire engine, near his home in Boston, on Leverett street, in the twenties, the "Rapid," with its painted motto,

> "The Rapid we move
> Our duty to prove."

It was succeeded about 1830 by the Major Melville, named for "the last of the cocked hats," immortalized by Holmes:

> "I know it is a sin
> For me to sit and grin
> At him here,
> But his old three-cornered hat,
> His breeches and all that
> Are so queer."

I saw him almost daily, and puzzled my young seven-year-old brain over the relation he bore to the engine, and to the picture in the engine house of Prospero with his wand, and the legend, "Mark me now. Now will I raise the waters." Now an efficient company will, within fourteen seconds after an alarm of

fire, take its horses from their stalls, hitch them to the machines, and drive out of the building. The water is always kept hot by steam circulated through it from a boiler below; and a light so arranged that as the engine moves out in response to a call for a fire, a gas flame ignites the kindling in the fire-box so that in a gallop of a short distance, steam is up and the engine ready for operation when it reaches the locality of the fire. A steam fire engine can throw water to the height of 150 feet, and on a level to a distance of 250 feet with an inch and three-quarter nozzle; or with an inch and a quarter nozzle, will throw a vertical stream 220 feet, and horizontally a distance of over 300 feet. The Clapp & Jones, the Button, the Ahrens, the Amoskeag and others are well known.

The fire extinguisher was invented in 1849. The Babcock is well known, as is Parmlee's automatic sprinkler, invented in 1880, Holloway's, Mahan's, etc. Some of them project water and carbon oxide; others a liquid, which heated, liberates a fire - extinguishing gas. Fire-escapes in great variety are in use to enable those in burning buildings to escape. Fire-boats, in rivers and harbors, accomplish wonders in extinguishing burning shipping. Then there are fire-trucks, fire-ladders, fire-hose, water towers, fire tools of many kinds, for removing iron shutters, cutting tin roofs, iron bars, electric wires, etc., the use of which was undreamed a hundred years ago.

The inventions of the century have not been mere improvements on previous methods, or new applications of the same principles, but they have been new in principle.

From earliest time till Washington's day military commanders sent news of victory or defeat by men on horseback or on foot, and sometimes weeks were required to advise the government of military transactions. Now wires, strung along on land or under sea convey the tidings of Dewey's victory before it happens, if the watch is to be believed. Kings and princes journeyed on land or sea by horse-power or sails, and could command no other facilities than the poorest. But the genii of the boiler outdoes Aladdin and transports the traveler with incredible speed, by means original to the Nineteenth Century.

We who are accustomed to travel in the floating palaces of our day at a speed of from twenty to thirty miles an hour, look back with wonder upon the first feeble attempts that were made to propel vessels by steam. The wonder increases that the discovery came so late as it did; for we are hardly able now to realize by what slow stages steam locomotion advanced to assured success. Now that steam itself is hardly swift enough to satisfy the demands of our hurrying age, the idea of traveling four or five miles an hour may well cause a smile; but to seriously consider that it is only three quarters of a century since even this slow rate of progress was considered one of the grandest achievements of modern times almost passes our belief.

Successful application of steam to

navigation is unquestionably due to the persevering efforts of Robert Fulton; because, while Fitch and others had the same idea that he had, and were pursuing it in their own way, he outstripped them in the race by superior genius. Many had already tried and failed where Fulton at last succeeded, so that the world gives no more than its just reward to his patient and unremitting labors when it places Robert Fulton's name upon the roll of benefactors, "not for an age, but for all time."

Yet how simple the problem seems to us in the light of present knowledge! To so apply the power of the steam-engine to a shaft as to drive a water-wheel,—this was all. And how to do it was puzzling the inventors of Watt's and Fulton's day, —inventors who had already settled it in their own minds that the thing was entirely feasible. So indeed it seemed; for the steam-engines of Watt and Boulton were already doing wonders in the way of mechanical labor, and were slowly opening the eyes of inventors to the greater possibilities that lay in the future of steam power.

The achievements of steam and the wonderful deeds of those who have harnessed it to the needs of mankind all belong to this "Century of Centuries."

JAMES WATT.

[Born 1736. Died 1819.]

W. CAVE. THOMAS.

But we may be sure that, however great and numerous may be the improvements in steam machin- posterity will never forget the name of James Watt nor disown their obligations to his genius. pen of Brougham has not exaggerated his merits in the epitaph on the statue of James Watt in stminster Abbey executed by the chisel of Chantrey. The great lawyer was well employed when wrote it; and so was the great sculptor when he preserved in marble the memory of so great a man.

CHAPTER V.

SPINNING, WEAVING, AND THE COTTON-GIN.

TAFF, SPINDLE AND HAND LOOM OF 1800—THE COTTON-GIN—ELI TNEY—THE MACHINE CARD—THE POWER LOOM—THE CARPET LOOM—HINES FOR WEAVING HOSIERY, UNDERWEAR, ETC.

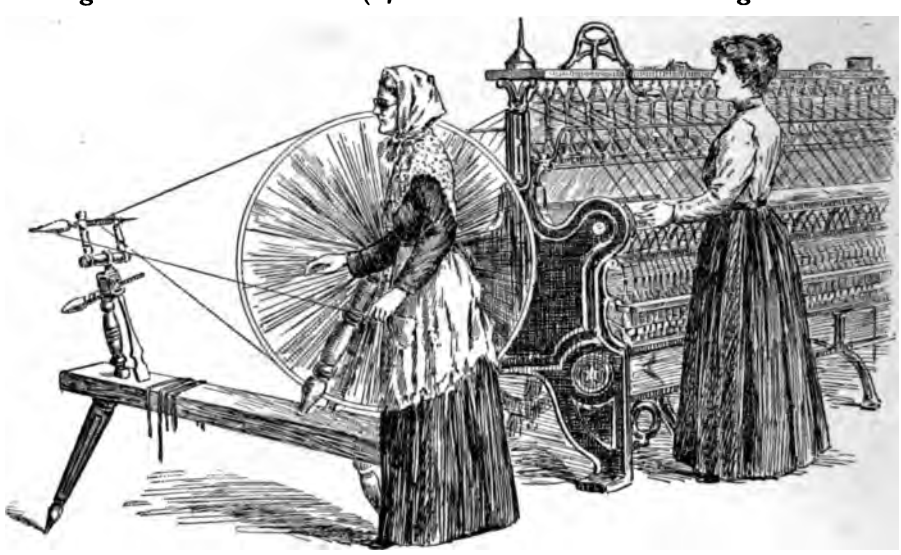
: distaff and the spindle pre-
ded the spinning wheel, and
e latter was followed by the
; jenny, invented in 1768 by
Iargreaves (1778——); Rich-
:wright (1732-1792), in 1769,
l the mule, which was an im-
:nt on the machine of Har-
Others claim to have in-
the spinning machine—
Crompton (1753-1827), Wy-
Higley. None of these be-
our century, but their inven-
d the foundation for subse-
nprovements.

tton-spinning all the opera-
: great improvements on the
ry in use even a decade ago.
proved revolving flat card is
:ial advance on all previous
The modern drawing and
rames, and the spinning ap-
have constantly improved
e invention of the top spin-
F. J. Rabbeth. Before that
wyer machine averaged a
7,500; the Rabbeth attains
Cotton-spinning has made
dvances in ten years, and
by the invention of improved
ry. Hand weaving was
m remote antiquity, but the
wer loom was the invention
of Rev. Dr. Edmund Cartwright (1743-1823), in England, in 1787. James Bogardus (1800-1874), in 1829, invented the ring flier for cotton-spinning.

The foundation of successful cotton spinning and weaving was laid by the invention of the cotton-gin. Eli Whitney (1765-1825), a Massachusetts school teacher, in 1792 went to Georgia to improve his fortunes, and while there, though he had never seen raw cotton or cotton seed, at the suggestion of the widow of the American general, Nathaniel Greene (1742-1786), he shut himself in a room to wrestle with the problem of a machine that should be able to separate the fibre from the seed. He succeeded in the invention, which, tested, enabled one man in a day to do more than could be done by a hand in a month. But he never reaped the financial benefits to which he was entitled. He received some returns, but the opposition of the people drove him from the South, and he sank all he received and more in protecting his rights from infringement. And yet, his invention created the prosperity of the South, for before the gin was invented cotton could not

be profitably produced. He was the great benefactor of the South, which refused to protect his rights or compensate the man who had created its prosperity. "What Peter the Great did to make Russia dominant," said Lord Macaulay, "Eli Whitney's invention of the cotton-gin has more than equaled in its relation to the progress and power of the United States."

He returned north, and under the patronage of Oliver Wolcott (1726-1797), then Secretary of the Navy, he began the manufacture of firearms for the Government. He was the first person to make a musket so that each part could be fitted to any other musket. Thanks to the patronage of Governor Wolcott, who was then Secretary of the Treasury, Whitney ultimately amassed a fortune in the manufacture of arms, having introduced many novel features in the machinery he used, as well as the finished weapons he turned out. All his efforts to procure a renewal of the patent-right to his cotton-gin were, however, defeated by the Southern delegation in Congress; and so this gifted inventor and benefactor had the hard fortune to see his invention everywhere in successful use, and its merits fully acknowledged, while he stood begging for justice at the doors of those whom his genius had enriched.



SPINNING-WHEELS OF YESTERDAY AND TO-DAY.

Robert Fulton thought that Arkwright, Watt, and Whitney were the three men who had done the most for mankind of any of their contemporaries. Judge Wm. Johnson (1771-1834), in his decision in relation to the cotton-gin, declared that the debts of the South were liquidated, its capital immensely increased, and its lands trebled in value by the invention of the cotton-gin. One woman before Whitney's invention could only clean one pound a day. Now, one man with a two-

horse power can clean five thousand pounds. There are many modern gins in use, but the great glory of the invention belongs to the Yankee schoolmaster, Whitney. The gin ranks with the railway and the telegraph in promoting industrial prog-

ELI WHITNEY STUDYING HIS COTTON-GIN.

ress. The modern cotton-gins—the Eagle, the Brown, and the Mason—are wonderful improvements on the original machine.

The card is an instrument for combing wool, flax or cotton, employed to disentangle or tear apart the tussocks, and lay the fibers in parallel order that they may be spun. It is a wire brush in which the teeth are inserted obliquely through a piece of leather, or of cotton, linen, or India-rubber, which is then nailed to a wooden back. Previous to 1812 all the cards in use in manufacturing cotton and woolen goods were made by hand. The wire staples were laboriously stuck into sheets of leather. Oliver Evans, born in Newport, Del., and died in New York, invented the first crude form, but it was afterward perfected, in 1812, by Amos Whittemore (1759-1828) and others. This machine comes as near seeming to act as though it were endowed with thought as does any machine known to us. Whittemore made a fortune by his invention.

Isaac Holden, of England (see "Friction Match"), having invented the friction match, in 1830 turned his attention to industrial pursuits. He invented the wool-comber, which takes the raw wool, combs the fibers out, places them parallel, separates the long fibers from the short, and draws out the former into one united sliver, in which condition it is ready to be submitted to the spinning process. The slivers thus produced are called "tops." The wool-combing machine is one of the costliest single inventions the world has known. It was as far back as 1790 that Dr. Cartwright, inventor of the power loom, took out a patent for wool-combing. In 1847 Holden took out a patent jointly with S. C. Lister. The wonderful amount of experiment that has been made from time

A PRIMITIVE COTTON-GIN.

to time in the creation of the wool-combing machine is to some extent indicated by the statements made by Sir Isaac before the Royal Commission. He said he had been told that experiments connected with the combing of wool have cost the ex-

perimenting inventors the sum of $10,000,000.

In 1811 Francis C. Lowell (1775-1817), of Boston, visited England to study the cotton manufacture, and with the skill of Paul Moody and the encouragement of Nathan Appleton (1779-1861) and Patrick T. Jackson (1780-1847), in 1814, the loom that Mr. Lowell had perfected became part of the first complete cotton factory in the world, in Waltham, Mass. It had 1,700 spindles. From this beginning came Lowell, Lawrence, Fall River, Manchester, N. H., and the enormous cotton factory interests of the United States.

ELI WHITNEY.

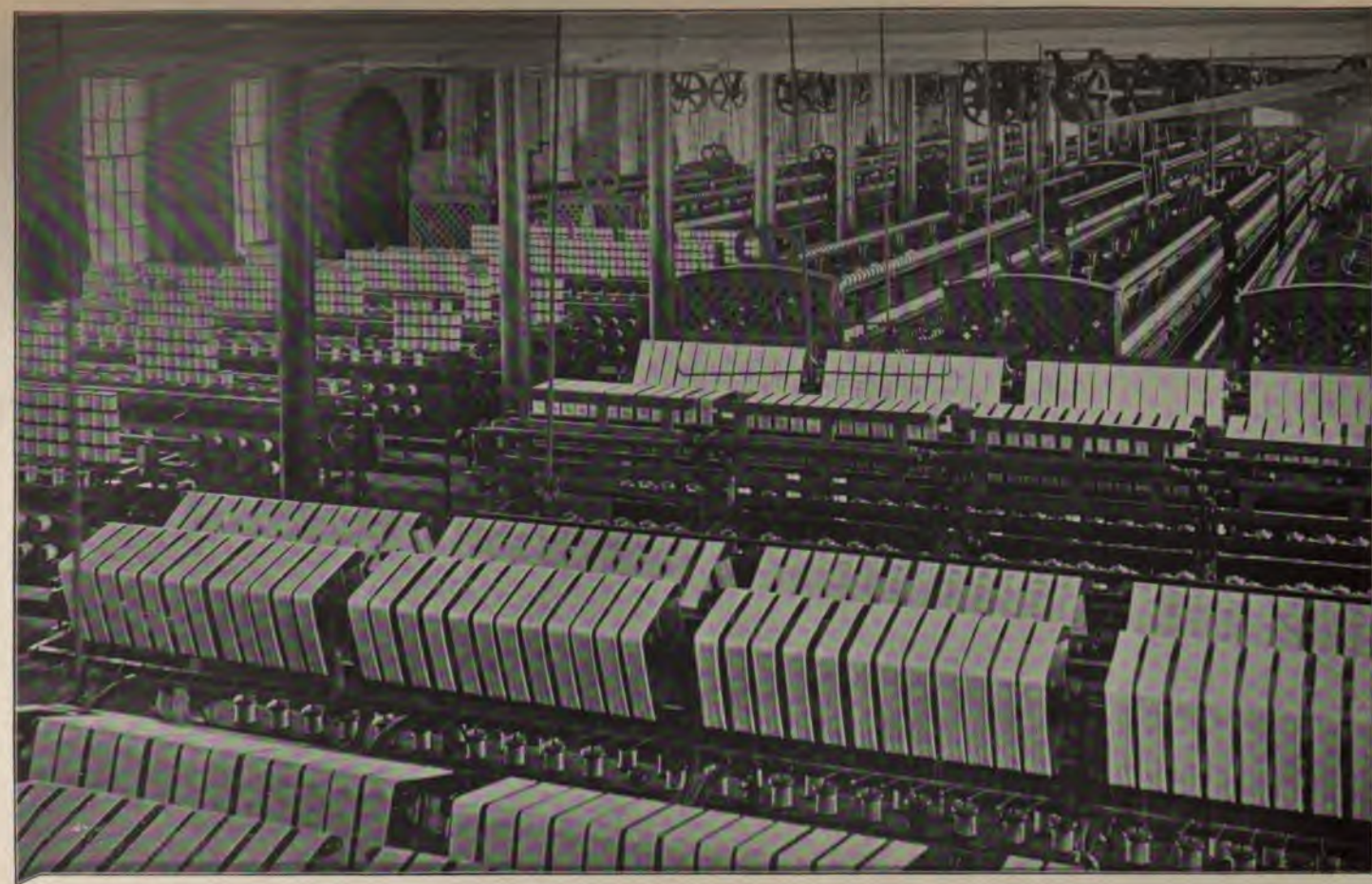
Though the power loom was invented in 1785, it did not come into use in England till, 1806, nor in this country until 1812 and 1815.

Lyall's positive motion loom is one of the greatest of modern inventions. It weaves all fabrics from the heaviest to the most delicate.

Formerly, America raised little cotton; she hardly manufactured any cotton cloth; she printed none; power looms had, even in England, not entirely superseded the ancient hand looms, on which weavers in their own cottages wove their webs. Workmen were bitterly opposed to the introduction of machinery, not forseeing that the increase of production would give employment to hundreds where one would have got a living under the old system.

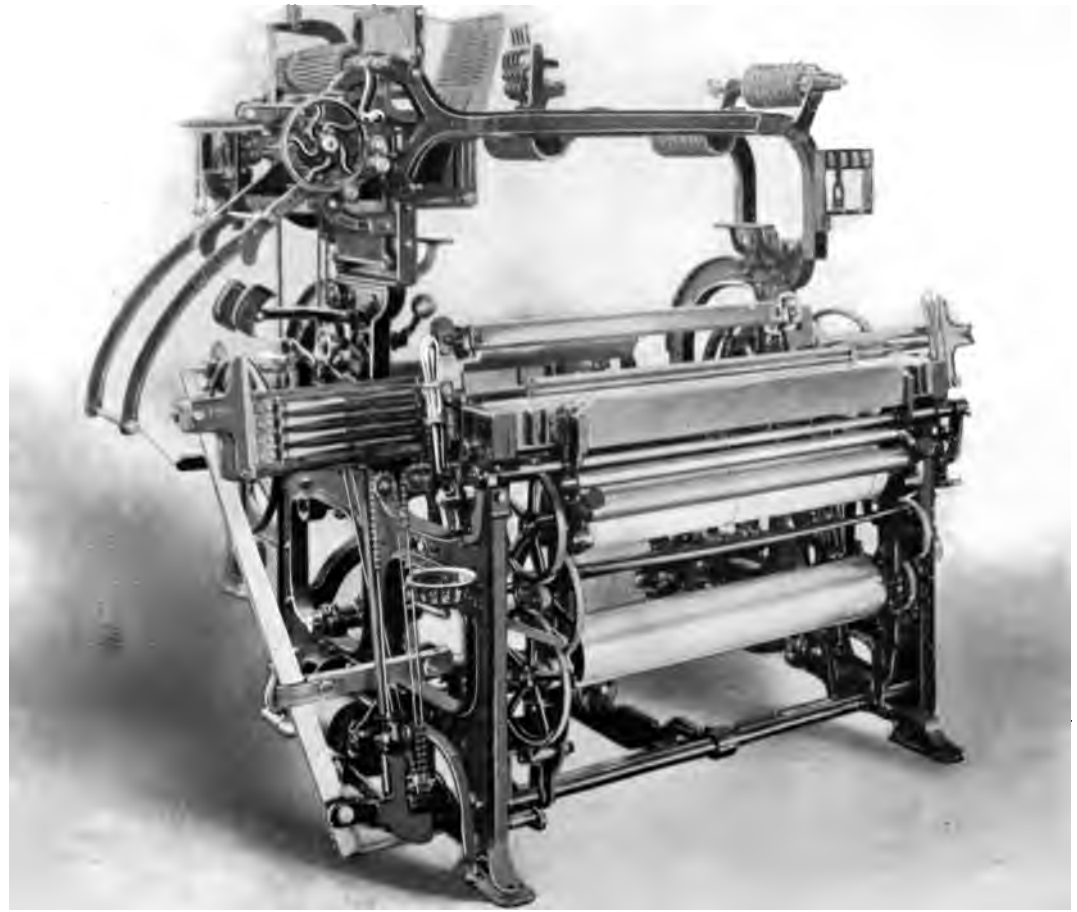
In 1800, Joseph Marie Jacquard (1752-1834) produced a model of his automatical attachment for the weaving of figured goods, and met with success, receiving a medal for his invention at the National Exposition, in 1801. The appendage to the loom, which constitutes the Jacquard attachment, is to elevate or depress the warp threads for the reception of the shuttle, the action being produced by cards with punched holes, which admit the passage of needles which govern the warp thread. For figured stuff, from the finest silk, to the most solid carpet, figured velvet and Wilton carpets, we are indebted to the genius of Jacquard, who made it possible to do by machinery what was before an expensive operation, requiring skillful hands. The process of preparing the perforated patterns for the loom is no small task, especially in the larger works. For heavy materials, the cards must be of sheet iron. It is said that an elaborate damask design may require as many as 4,000 cards and 400 needles.

The weaving of carpets in Europe



SILK LOOMS.

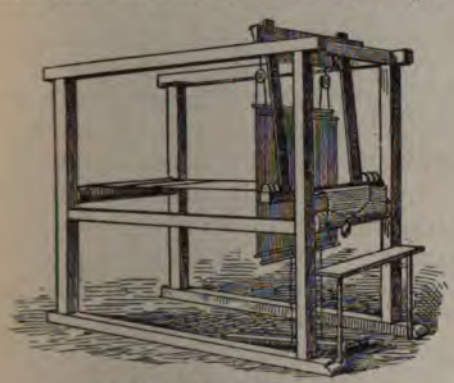
"In the early part of the century all articles of wearing apparel were made by hand."



A STEAM LOOM.

"The power loom is one of the greatest of modern inventions."

was for many years done at the hand-loom. The Jacquard attachment simplified very much the weaving of patterns. Until this method of weaving, eight yards a day was considered all that could be done by a



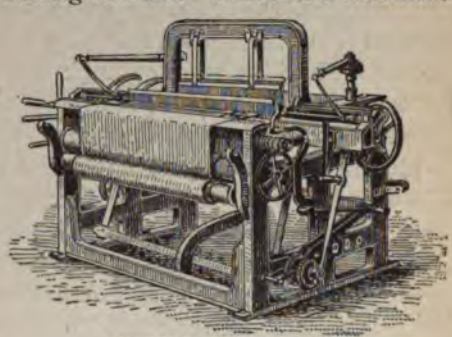
OLD-FASHIONED CARPET LOOM.

single person in weaving "two-ply ingrains." Hand-made rugs and carpets have been used from remote antiquity, but at such cost as kept them out of reach of all but the rich. In 1839, E. B. Bigelow (1814-1879), Boston, invented the carpet power loom, a most ingenious piece of machinery that almost seems to possess human intelligence. Carpets are now accessible to people in humble life, and millions of yards are produced annually by all the leading nations. But not many generations ago straw and rushes were spread on the dining-room floors of nobility and royalty.

For many years stockings had been knitted by machinery in strips, and seamed at the edges afterward, but M. I. Brunel (1769-1849), in 1816, made a machine that knitted the circular product. Brunel died in England. Lee invented machinery for weaving underwear, gloves and many other articles. In 1831 Timothy Bailey, of Albany, attached power to knitting machines. Later Rev. I. Lamb invented a knitter, which manufactures all kinds of garments. And yet only a century or two ago, women of wealth and station, wore cloth wrapped around their feet—if they wore any substitutes for stockings.

Anciently all lace was hand-made, and much of it is at present, but in 1809 John Heathcote (1784-1861) invented the bobbin-net machine. He was born in Leicestershire in 1784. He was a farmer's boy and worked at his invention from the age of fifteen, ten years before he perfected the machine that made him prosperous and rich, and brought lace within the reach of "common people."

Sir Richard Arkwright, born 1732, died 1792. As the founder of the now enormous cotton-factory system of the world, Sir Richard Arkwright confessedly takes rank among the most active and foremost



MODERN CARPET LOOM.

of the benefactors of his country and of his race. The bringing to perfection of his spinning-jenny alone has rendered his name lasting, while his other improvements in machinery and modes of manufacture add

to the luster of his name and to the veneration with which his progress in manufacturing improvement is regarded.

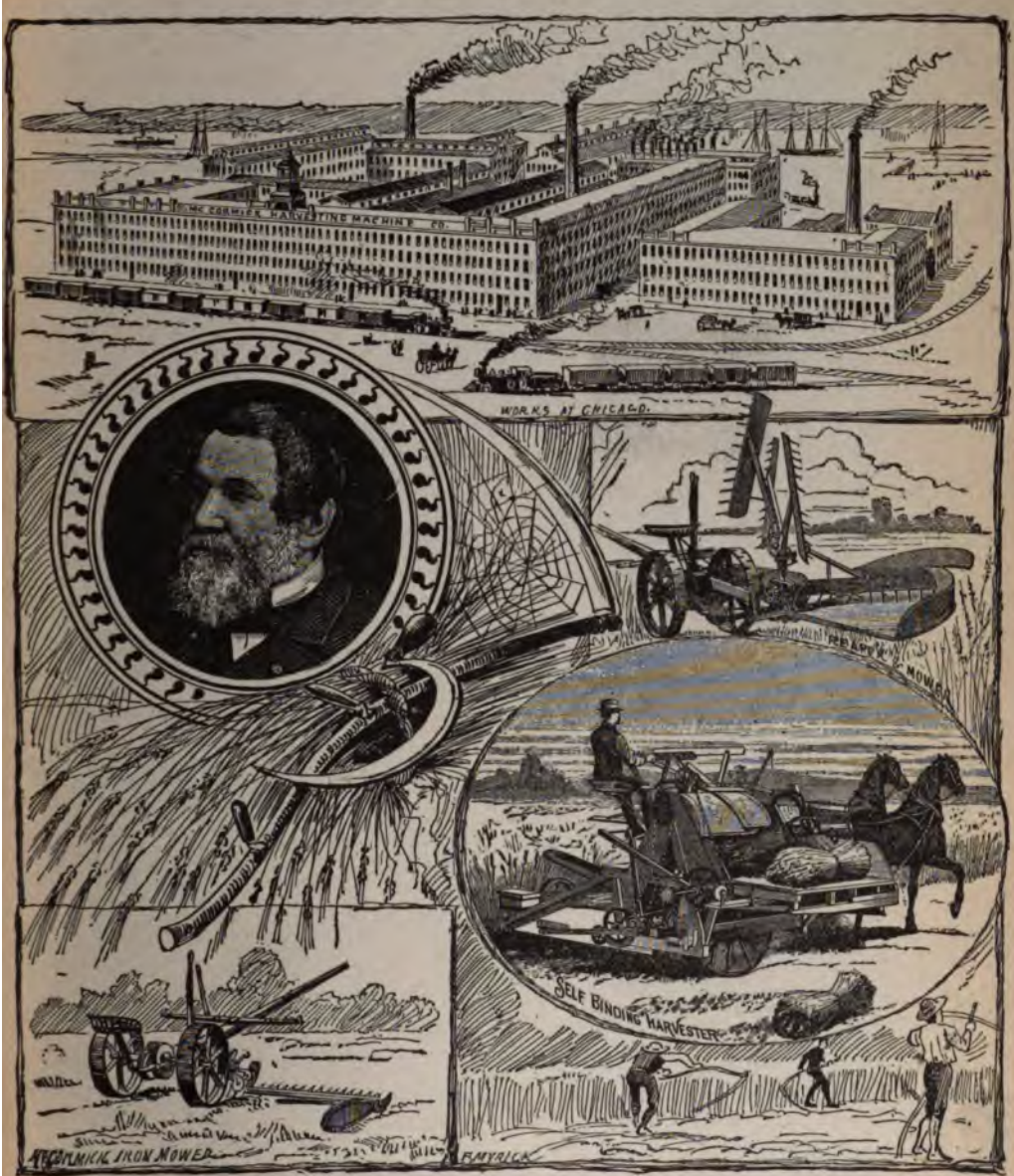
Born at Preston, in Lancashire, England, Richard Arkwright was the youngest of a family of no less than thirteen children. His parents were so poor that he was never at school a single day, and grew up as best he might without help. As soon as old enough he was put to learn the trade of a barber, and in 1760 commenced business for himself in an underground shop or cellar at Bolton, over the door of which, it is recorded, he put up a board bearing the words, "Come to the Subterraneous Barber. *He* Shaves for a Penny," and by his low price got away much of the trade from the other shops in the town.

Having become acquainted with a clockmaker at Warrington, named Kay, and got him to assist in his "perpetual motion machine," Arkwright received from him some hints and particulars regarding an invention of his own for spinning by rollers. "The idea at once took firm possession of his mind, and he proceeded to devise the process by which it was to be accomplished.' To this he entirely devoted himself, and he and Kay constructed a machine which they set up in a room at Preston; but, fearing its destruction by a mob, he first took it to Nottingham, where he obtained pecuniary aid from Messrs. Wright, the bankers, and afterward, at their suggestion, to Jedediah Strutt, the inventor of the "Derby Ribbed Stocking Machine," and his partner Mr. Need. Mr. Strutt—himself, through his inventions, a no small benefactor of mankind,—at once entered into a partnership with Arkwright, a patent was secured, and cotton mills erected which ultimately made the fortunes of both the Arkwrights and the Strutts. From that time forward the machinery was constantly receiving improvements and becoming perfected; but the opposition he met, not only from the working people, but from other manufacturers, nerved Arkwright to still greater efforts. Like George Stephenson and other great men, he "persevered," and success abundantly crowned his efforts. The mills at Cromford, in Derbyshire, built by him and his partners, became at the expiration of the partnership his own property.

"It is not every inventor, however skilled," says Mr. Smiles, "who is a veritable leader of industry like Arkwright. He was a tremendous worker, and a man of marvelous energy, ardor, and application to business. At one period of his life he was usually engaged in the severe and continuous labors involved by the organization and conduct of his numerous manufactories from four in the morning until nine at night. At fifty years of age he set to work to learn English grammar and improve himself in writing and orthography. Be it for good or evil, Arkwright was the founder in England of the modern factory system, — a branch of industry which has unquestionably proved a source of immense wealth to individuals and to the nation."

CYRUS HALL McCORMICK.

[Born 1809. Died 1884.]



Even the most superficial study of the character of Cyrus H. McCormick shows us a man who would unquestionably have made his mark upon the age in any calling. A closer look forcibly suggests that admirable relation which such men hold to certain eras of extraordinary progress in the world's history. In McCormick we discover an inventor by heredity, but pre-eminently an inventor of the kind in whom an idea once seized upon becomes the fixed purpose of a lifetime.

CHAPTER VI.

AGRICULTURE.

PRIMITIVE METHODS OF 1800—IMPROVED IMPLEMENTS—MACHINE SOWERS—REAPERS—THRESHERS, ETC.—CYRUS MCCORMICK—THE GREAT REAPER—IMPROVEMENT IN SIZE, WEIGHT AND BEAUTY OF HORSES, CATTLE, SWINE, FOWLS.

AGRICULTURE has made a greater advancement during the century than it had previously accomplished in all the years of human history since "Adam delved and Eva span." Except the scythe, the sickle, the flail, the spade, the shovel, the hoe, the rake, and a rude wooden or iron plow, the implements of husbandry were anciently very few. The labor-saving agricultural inventions that have lightened man's burdens and increased his productive capacity many fold are all modern. A hundred years since every acre of grass for hay was cut and raked by the human hand; every sheaf of rye, barley, oats or wheat was reaped by the sickle, and brought into windrows by hand-rakes; maize was planted with the fingers and shelled by the hand. All grain was threshed by the flail, and every process of preparing food for human uses was laboriously pursued by manual toil. Labor-saving machinery had not been invented. Now all the cereals are planted and gathered by ingenious devices that release man largely from the servitude of labor, and enable him to accomplish in an hour what once required the toils of a day.

Says Professor Mackenzie, in his "Nineteenth Century": "The alternation of crops was unknown. No means had been found of restoring to the soil, by manuring, the elements of which the plant had deprived it. A field exhausted by frequent repetition of the same crop was suffered to lie waste for an indefinite period, till nature restored the expended capability. Drainage was practiced, but on a scale as limited and in a form as rude as those which were in use among the Romans. The water which soaked the ground caused the crops to ripen late, diminished their quantity and impaired their quality; it stunted the growth of cattle, which have more than doubled in weight in the last hundred years; it diffused ague and intermittent fevers among men. The implements of the farmer were of the most primitive type. His plow was a rude structure, which only scratched the surface of the ground. The sower went forth to sow equipped as he had been in Palestine eighteen centuries ago. The ripened grain was cut by means of the ancient reaping-hook. The 'thresher's weary flingin'-tree,' so painfully celebrated by Burns, still

formed the sole agency by which grain was separated from straw." Compared with the present time agriculture in 1800 was indeed in a crude condition. Liebig for the first time, about the middle of the century, taught the agriculturist that he must supply his land with phosphoric acid, potash, and nitrogen, or his crops would exhaust its fertility.

According to the American Encyclopaedia no hoed crops or edible vegetables were anciently cultivated, and even as late as in the reign of Henry VIII., Queen Catherine was obliged to send to Flanders or Holland for salad to supply her table. Neither Indian corn, nor squashes, nor carrots, nor cabbages, nor turnips, were known in England till after the beginning of the sixteenth century. The peasants subsisted chiefly upon bread made of barley, ground in the quern, or hand-mill, and baked by themselves. The tenant peasantry had no security for their property till after the fifteenth century. If the estate was sold by the landlord, they were obliged to quit all, giving up even their standing crops without compensation. They were liable for the debts of the landlord to an amount equal to their whole property, and it was not till after that time that they were held only for the amount of rent due from them.

PRIMITIVE METHODS OF GATHERING AND CRUSHING SUGAR CANE.

There are now all kinds of plows for all kinds of use—gang plows, double plows, subsoilers, plows for digging beets, potatoes, turnips; rotary plows and steam plows, the latter invented in England in 1832 by Heathcote, and sulky plows in which the worker rides at his work. The steam plow was invented in England, in 1859, by John Fowler (1826-1864).

In the seventeenth century rough attempts had been made to sow seed by machinery. A plow, a seed box, and a harrow were united, but the scheme does not seem to have been successful. Plows with anti-friction

wheels were invented in England and Scotland about 1813-15; the hay-tedder by Robert Salmon, 1800 (1763-1821). In 1786, Pitt, an Englishman, made a machine which had a revolving cylinder, with rows of combs or ripples, which tore off the grain and discharged it into a box (as had been done in Gaul, A. D. 70). Six or seven other machines followed in England within the next thirty-six years. In 1822 Ogle, a schoolmaster, and in 1827, a Scotch minister, Rev. Patrick Bell (1800-1869), invented a reaper, which contested unsuccessfully McCormick's invention. In 1822 a self-sharpening mowing machine was patented in this country. Bell's machine involved the principle on which all modern reapers are constructed. The idea came to him while cutting a hedge with gardener's shears, and he applied it to the cutting of grain. In 1867 he received a testimonial of $5,000 for his invention. Between 1852 and 1874 nearly three thousand patents for reaping machines were taken out in the United States.

The threshing-machine was suggested and rude attempts to perfect it were made during the last century; in 1758 by Menzies, and by Meikle (in Great Britain) in 1786. Sixty years ago a quarter of an acre a day was a reaper's work with the sickle. Now a man and two horses will cut fifteen or twenty acres in a day. The threshing-machine will thresh ten times as much in a day as the flail.

The reaper and mower have been invented and improved thus, all by British inventors: Pitt, 1786; Boyce, 1799, six rotating scythes; Plunket, 1805; Gladstone, 1806; Salmon, 1807; Ogle, 1822; Bell, 1827. By American inventors: Bailey, 1822; Ten Eyck, 1825; Lane, 1828, reaper and thresher; Manny, 1831; Hussey, 1833; McCormick, 1834; Randal, 1835. Australian inventors: Ridley, 1836; Knowles, 1837; Wheeler, 1838; Lamb, 1840; Heath, binder, 1850; Watkins, 1851, automatic binder; Barta, binder, 1871; James F. Gordon, binder, 1872-74; and among other binders of more or less note, Carpenter, 1868; Fowler, 1870; Clinton, 1869; Withington, 1872; and Whitney, 1874.

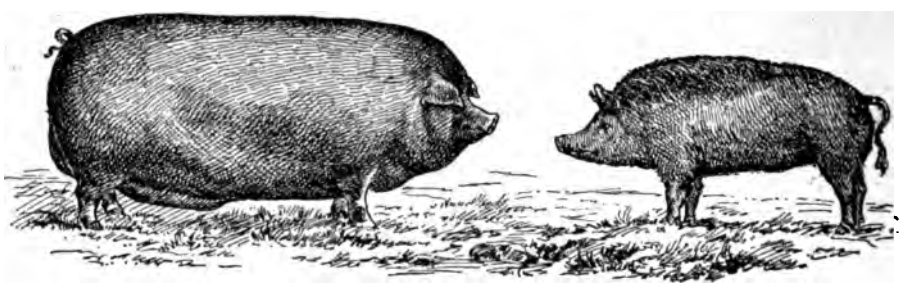
The most celebrated reapers and binders are McCormick's, Wood's, Mann's, Osborne's, Aultman's, and the mowers are the Buckeye, New Champion, Wood, etc. McCormick's harvester appears to be the most successful of all the similar inventions.

Cyrus Hall McCormick (1809-1884) was born in Virginia, a farmer's boy. At the age of fifteen he evinced his mechanical aptitude by inventing a cradle, which was used in the harvest field. His father, Robert (1780-1846), was an inventor who made several mechanical discoveries, among which was a reaping machine, in 1816. It was not successful, and being discouraged and occupied with other matters, he laid it aside and did not take it up again until 1831. His machine was too elaborate and complicated. Cyrus's next invention after the cradle was a side-hill plow for throwing the furrows down hill, which was followed, in 1833, by the

invention of a self-sharpening, horizontal plow. Meanwhile he had been watching his father's efforts to invent a reaper. He thought that

A WHEAT FIELD FIFTY YEARS AGO.

his father in attempting to separate the grain into bunches before cutting had made a mistake; that the grain should be cut as a single body, and he supplied the requisite motion laterally by a crank attached to a reciprocating blade. In 1834 he patented his reaper, and in 1845-6-7-8, other improvements. In 1847 he removed to Chicago, and since then his invention has been a household word in all the civilized world. Mr. McCormick devoted much of his vast wealth to benevolent uses.



THE HOG IN 1900. THE HOG IN 1800.

Reverdy Johnson declared in 1859 that the McCormick reaper was worth $55,000,000 a year to this country, and W. H. Seward said that it caused the line of civilization to move westward thirty miles a year. The French Academy of Sciences described McCormick as having done more for the cause of agriculture than any other living man. With the sewing machine and steam engine the reaper ranks as one of the most important labor-saving machines of the century.

In 1831 McCormick turned out the first successful reaper ever made, having the essential features of the present reaper—a vibrating cutting-blade, an arrangement to bring the grain within reach of the cutter, a platform to receive the grain, and a divider to separate the grain to be cut from that to be left standing. From 1831 to 1840 he did not sell a reaper, as he was not willing to run the risk of imperfect success.

The machine shop of 1800 was inferior to the blacksmith shop of today. All pulleys had square holes to receive shafts, as no machinist of that day could fasten a pulley with a round hole upon a round shaft. Planers for iron were unknown. All flat surfaces were smoothed with cold chisel and file. There were no such things as adjustable chucks. The Morse drill, from two inches to one-fiftieth of an inch, with adjustable chucks to hold it, was not

HARVESTING MACHINES.

"The Harvester is among the greatest modern labor-saving machines."

THE MAN WITH THE HOE.

dreamed of. Automatic bolt and screw cutters are modern ideas. So in 1830 McCormick could not make his reaper work for lack of mechanical skill and tools to materialize his ideas. Now tools and machinery are made to accomplish the perfection of the most ingenious mechanical design. The harvester not only reaps but threshes, winnows, and delivers the grain into sacks at one operation. Three million five hundred thousand McCormick reapers and harvesters are in use all over the world. Much improved, of course, from the machine of 1831—but the germ was there.

The Deering Harvester is among the greatest of modern labor-saving agricultural machines. The Deering Harvester company was founded by William Deering, in Massachusetts, in 1871, and began business in Chicago in 1873. The present plant was located in Chicago in 1880. It covers eighty-five acres. The company employes 7,000 hands in the factories and has 2,000 more employes outside. This great institution is an object lesson to illustrate agricultural progress in a hundred years.

The horse hoe and harrow were invented in 1830; evaporator of fruit, Hoard's, 1838; Stillman's, 1846; the corn harvester and corn planter early in the century.

There seems to be no end to the number of uses for Indian corn that are being discovered. Before long corn promises to be one of the most profitable crops that can be raised in the United States. A method has been invented of removing the outer covering from the stalks and grinding them, so that they make excellent cattle food. The pith of the corn-stalk is also being used as a lining for battleships, and for other purposes. The chemists of the Glucose Sugar Refining Company have discovered a process for vulcanizing the oil from corn, in such a manner as to produce rubber. They have found that the oil of the corn, properly treated and vulcanized, is superior to that of the product of the South American rubber tree, is more resilient and more lasting, and it is said that the manufacture of rubber under the new process will become an important part of the business of the Glucose Company. The process was accidentally discovered. The new process will greatly lessen the cost of rubber, especially that variety that is used in the manufacture of bicycle tires, which is required to be thin, durable, and resilient. It is claimed that the new variety of rubber will withstand much more pressure than that now in use for tires, and that it will offer more resistance to outside force. Already in 1898 paper is being manufactured from corn-stalks.

The improvement of domestic animals, the horse, the ox and cow, the sheep and swine, poultry, etc., during the century is very great. A striking illustration is seen in the Durham short-horn breed of cattle, characterized by short-horns, rapidity of growth, aptitude to fatten, and good temper. It was produced by Charles and Robert Colling, at Ketton and Barmpton, near Darlington, England, by a process of

in-and-in breeding, between 1780 and 1818. The Collings were imitated by R. T. and J. Booth, between 1814 and 1863, and by Thomas Bates between 1818 and 1849. The process has been followed in America from 1817

FIRST AMERICAN REAPER.

onward. The breed has run into several sub-breeds, those of the northern counties of England generally surpassing those of Scotland and of the south. So of the Jerseys, Alderneys, Galloways, domestic fowls, etc.

Probably no one over sixty ever saw a tomato or grape fruit till he was at least ten years old.

GIANT STEAM REAPER CUTTING A SWATH TWENTY-TWO FEET WIDE.

The Washington navel orange is one of the agricultural achievements of the century. The American consul at Bahia, Brazil, had found the navel orange growing wild in Brazilian jungles, and had sent a few sprigs of the tree to the Department of Agriculture in Washington. Attempts to grow the tree in the gardens there failed. Three sprigs were sent in 1873 to Luther C. Tibbetts, at Riverside, Cal., and under his care they flourished and bore fruit.

Vast improvements have been accomplished in agriculture by Agricultural Societies, established for the promotion of agriculture; Agricultural Colleges founded for the education in agricultural pursuits of those who desire to follow that vocation, and Agricultural Chemistry, the department of Chemistry, which treats of the composition of soils, manures, plants, etc.,—these and other agencies have wonderfully developed the science during the Nineteenth Century.

Every new invention in agriculture as in manufactures, in proportion to its importance, produces like economic results. First, it destroys somebody's industry and makes some capital, for a time, useless; next, it changes the location of the social units of society; then it increases the profits of those who possess exclusive control of the invention; but as soon as exclusive control ceases, competition steps in and reduces both the price and profits, until the invested capital usually re-

ceives only a fair rate of interest, and the effect of this is to so stimulate all industry that it opens up new avenues to commerce, subdivides labor, and lifts the standard of living, until this increasing demand for more and more wealth finally increases the demand for land—the original source of wealth.

Work on the great wheat farms illustrates the progress of the century. The smallest implement upon a big wheat farm is a plow. And from the plow to the elevator—from the first operation in wheat farming to the last—one is forced to realize how the spirit of the age has made itself felt here and has reduced the amount of human labor to the minimum. The man who plows uses his muscles only incidentally in guiding the machine. The man who operates the harrow has half a dozen levers to lighten his labor. The "sower, who goeth forth to sow," walks leisurely behind a drill and works brakes. The reaper needs a quick brain and a quick hand, but not necessarily a strong arm nor a powerful back. He works sitting down. The threshers are merely assistants to a machine, and the men who heave the wheat into the bins only press buttons. The most desirable farmhand is not the fellow who can pound the "mauling machine" most lustily at the county fair. He is the man with the cunning brain who can get the most work out of a machine without breaking it. The farm laborer in the West to-day, where machinery is employed, finds himself advanced to the ranks of skilled labor, and enjoys a position not widely different from that of the mill-hand in the East. Each is a tender of a machine.—William Allen White, in "Scribner's."

Ensilage, or silo, is a very modern invention. A roofed pit, or bin, stores green corn stalks, and other forage plants, for fermentation, which affords the very best of green food for stock in winter. Invented by Goffart, France. Ingenious machines have been invented for cutting the silage.

The development of the trotting horse has resulted in incredible speed, and what a few years ago was considered a wonderful performance is now looked upon as commonplace. The history of the rise of the trotting horse presents a constantly lower record of the time required to trot a mile. The names of individual American trotters are known all over the world, and the prices paid for some of them seem almost fabulous. The record for several years after the advent of "Maud S." remained stationary, but since has been eclipsed several times. "Nancy Hanks" trotted a mile, against time, in two minutes and four seconds, harnessed to a pneumatic sulky weighing sixty-two and a half pounds and accompanied by a running horse, on the regulation track, Terre Haute, Indiana, September 28, 1892. "Ayers P.," harnessed with running mate, "Telephone," trotted a mile, against time, in two minutes and three and a half seconds, at Kirkwood, Delaware, July 14, 1893. "Alix," in September, 1894, surpassed "Nancy Hanks" by one-fourth second, and "Robert J.," a pacing

horse, made a mile in two minutes and two and a half seconds. But all this was surpassed in the year 1897, when "Star Pointer" paced around the ring in one minute and fifty-nine and a fourth seconds, at the Readville track, near Boston, on August 28th. For that performance he is called the "horse of the century," and he deserves the name.

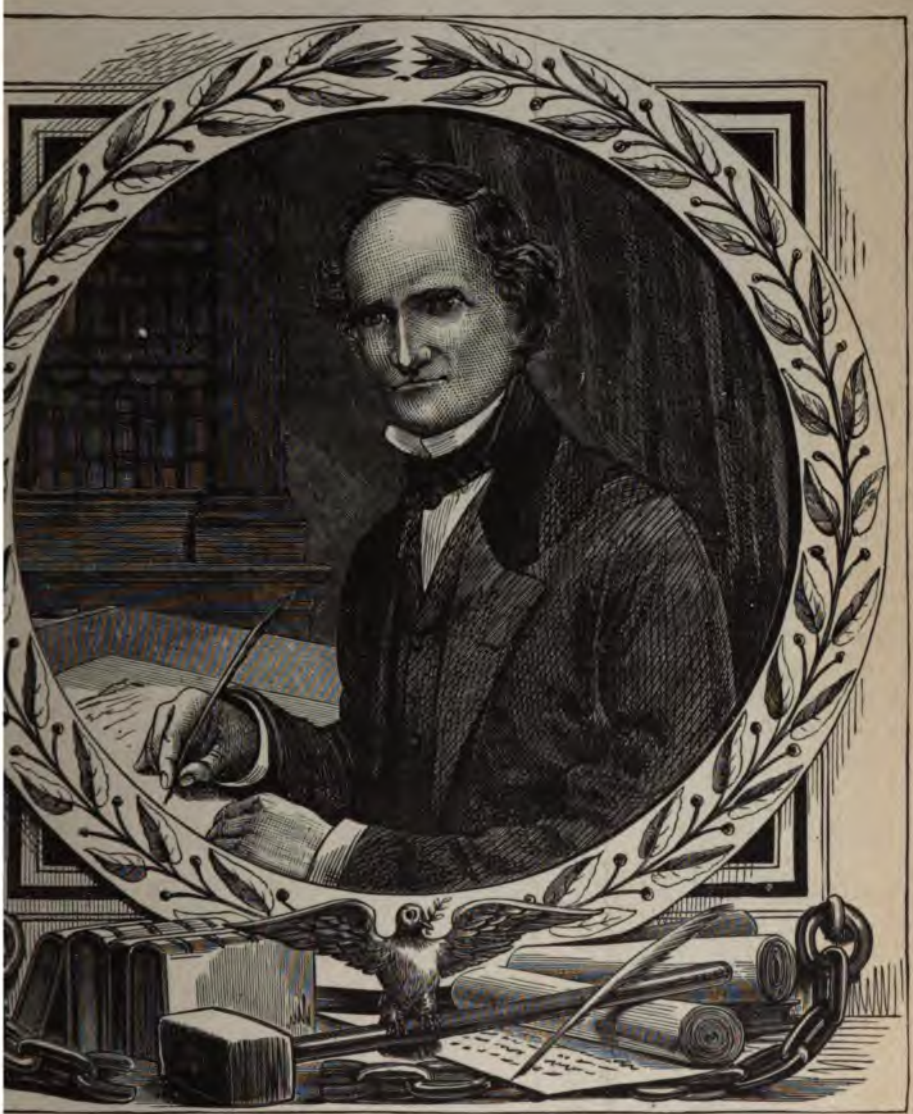
It would be impossible to name all the results now accomplished by machinery in agriculture. The tree is sawed, the stump is extracted, the soil is broken, cultivated and harrowed, the seed is sowed, planted, cultivated, and the crop is gathered by machines fitted to the purpose. Hay is mowed, raked, pitched and stored by machinery. Grain is planted, reaped, threshed, the straw stacked and the grain separated and winnowed by machinery. Cherries are pitted, raisins are stoned, in fact mechanical processes are in use for dealing with nearly every crop in nearly every stage, and thus a single workman can accomplish what a hundred years ago required the labor of several toilers, and the work is done in better shape. Steam engines move nearly all agricultural machinery.

One of the latest improvements is in harvesting the bean crop in California. There the Lima bean is not poled, but the vines run along the ground. The harvester cuts under the ground and the bean vines are heaped in great stacks, and when dry are threshed. The crop is planted and gathered by machinery, and by dispensing with poles the cost of production is reduced to a minimum.

The bare mention of the names of inventions, such as the apple-parer and apple-corer (1840), of which eighty patents have been granted, and other agricultural implements would occupy pages of this volume. The "Mechanical Dictionary" describes 492 machines under the head of "Agriculture," most of which have been devised during the last hundred years. There are innumerable mechanical contrivances for clearing, ditching and preparing land for seeds and for planting, cultivating, harvesting and preparing crops. At the present rate of improvement in mechanical contrivances applied to agriculture, the time seems not distant when the old cumbersome methods will be entirely dispensed with, and most of the work of the farm will be done by labor-saving machinery. Toward that result the Nineteenth Century has accomplished more than all its predecessors put together. In fact it is astonishing how little was known a hundred years ago of some of the simplest facts of nature. Linnæus had discovered the sex of plants, but it was not until 1815 that the embryo was recognized, nor until 1823 that the pollen tubes were discovered, and the century had nearly one-third gone when the natural system of botany succeeded the artificial. Agricultural schools and colleges now teach scientific farming. Such a thing was not known before the present century. In 1838 an agricultural college was established in Ireland, in 1855 one in Cleveland, Ohio. Since then one has been located in nearly every State. They are of great benefit to agriculture.

ELIHU BURRITT.

[Born 1810. Died 1879.]



hu Burritt was essentially a working man from the first to the end of his days. The improve-
f his people and country was his sole purpose. He never saw his own greatness. This he desired
ers; and when he stepped from his smithy floor it was direct to the platform to proclaim the
d golden principles of "peace on earth and good-will to men," and from these he was led into
ential side streams of temperance, abolition of slavery, ocean postage, development of indus-
tc., which he ably advocated in a weekly periodical specially commenced for the purpose.

CHAPTER VII.

LABOR AND WAGES.

LESS LABOR AND MORE WAGES THAN EVER BEFORE—VALUABLE FACTS—LABOR-SAVING PROCESSES BENEFICENT—LABOR ORGANIZATIONS PECULIAR TO THE CENTURY—THE POOR NOT GROWING POORER.

MORE than in any other equal period of the world's history, perhaps for the first time in the world's history, it can be shown conclusively that the great masses of men, especially in this country, have steadily increased in prosperity during the last hundred years. The old cry that "the rich are growing richer and the poor poorer" is not true. The present century has confuted the statement. If the rich are growing richer, and millionaires are increasing in number, it is certainly true that the poor were never so well off as to-day. The great statistician, Carroll D. Wright (1840——), in the Atlantic Monthly for September, 1897, shows that there were in 1870 "12,505,923, or 32.43 per cent. of the entire population, engaged in self-supporting pursuits. In 1880 the number had increased to 17,392,-099 and the percentage to 34.67. In 1890 the census returns showed an earning force of 22,735,661, which comprised 36.31 per cent. of the total population. In 1850 the average annual earnings of each employe engaged in manufacturing or mechanical labor, including men, women, and children, amounted in round numbers to $247. In 1860 the average was $289, and in 1870 it had advanced to $302. During this decade the absorption of so many thousands of mechanics in the war for the Union caused a transformation of industrial conditions and a reduction in the percentage of gain, and yet in 1880 the average earnings reached $347, and in 1890 they had reached $445." Mr. Wright is chief of the Federal Bureau of Labor Statistics, and his statement, amply fortified by facts and figures, shows that the number of poor people is decreasing relatively, and that the masses are improving their condition. Mr. Wright declares: "Analyz-

HENRY GEORGE.

ing the statistics, we find some remarkable results, and, in general, that the number engaged in the lowest walks of business, laborers and the like, is decreasing in proportion, while those employed in the higher walks are increasing in number relatively to the whole population."

Professor Mulhall, a well-recognized authority, in comparing the census data of 1850 and 1890, finds that between these periods the annual product of the factory operative has increased from $1,324 to $2,247. This increase in power must be attributed most largely to invention, and to the more effective co-ordination of capital and ability in management. Nevertheless, the result of this increase in productivity has been fully shared in by the operative, since it appears that, while his productivity has increased 70 per cent., his reward in the way of wages has increased 77 per cent.

W. H. Hallock states the facts in England: "In 1843 the gross income of the entire people—laborers, landlords, capitalists and all—was £515,000,000, of which £235,000,000 went to the laboring class. In 1893, fifty years later, the income of the laboring class had increased nearly 200 per cent. From all the data he deduces the conclusion that, through the aid of invention, the increase of capital, the marshaling of industrial forces, under the control and direction of ability, the working people now have divided among them a share, man for man, of the annual income of Great Britain larger than their fathers, in 1840, would have received had the whole public income of that period, from all sources, been divided among them. And while wages had been so increased the prices of the necessities and comforts of life had been wonderfully decreased." For example, wholesale prices for 223 articles of consumption from 1840 to 1890 show that wages had uniformly risen while the prices of commodities had fallen. Thus, a carpenter in 1840 received $1.40 a day, when calico was 12 cents a yard, and $3.50 in 1891 when calico was 6 cents. And as we go from 1800 onward we find the general rule to be that commodities grow cheaper and wages higher. To illustrate: In 1740 carpenters and mowers received 2 shillings and 6 pence wages, and paid 6 shillings per bushel for corn, or three times as much as now for corn, while receiving nearly five times as much for wages now as then. At about the beginning of the century carpenters' wages were one-fifth of the present rate, and Indian corn, the staple of life then, considerably more than now. And what we regard as the necessities of life now were unattainable luxuries by them. They were, without exception, more costly than now, while their wages were far lower, with more hours of daily labor.

Mr. Wright, in his invaluable "Industrial Evolution of the United States," gives the wage rate of different periods, and demonstrates the wonderful improvement in the condition of laborers. In 1800, carpenters, 70 cents a day; in 1810, $1.09; in 1820, $1.13; in 1830-40, $1.40. Unskilled laborers, 1800, $0.62½ a

day; 1810, $0.82; 1820, $0.90; 1840 to 1860, $0.87½ to $1.00. Printers, 1800, $1.00 a day; 1860, $1.75. Shoemakers, 1800, $0.73½ a day; $1.70 in 1860. Cotton-mill operatives, $0.44 a day, 1820-1830; $0.90 from 1830-1840; $1.03 in 1850. In 1831 agricultural laborers from $0.57 to $1.50 a day; blacksmiths from $1.00 to $1.25; paper-mill operatives in 1831, $0.66; printers, $1.25; shoemakers, $1.06; millwrights, $1.21. The wages of overseers in a cotton factory in Massachusetts were $2.00 for thirteen hours in 1842, and $5.00 for ten hours in 1891. Common laborers in the same business, $0.71 and $0.69 for thirteen hours in 1842, to $1.03 and $1.64 for ten hours in 1891. Carpenters in New York in 1843, $1.50 a day for ten hours, and $3.50 in 1891 for eight hours. Bricklayers and helpers, $1.75 and $1.00, respectively, in 1851, to $4.00 and $2.50 in 1891, with eight hours instead of ten. Something like the same proportion extended through all branches of labor. Mr. Wright makes a comparison derived from consultation of pay-rolls and finds, taking 100 as the standard, that, in twenty-two industries they were 87.7 in 1840, and in 1891 160.7, or nearly double.

The invention of labor-saving machinery has seemed to throw multitudes out of work, but this has been but a temporary effect,—in the end each invention has increased the demand for labor. The machine reaper does the work of many hands, but it has promoted a supply that has increased the acreage of wheat, and furnished millions for exportation. The machinery for boot and shoe making enables one man to do the work of many, but the commodity is cheapened, and the boot and shoe industry employs more hands at better wages than before the advent of machinery. The sewing machine seemed to displace the sewing woman, but in reality many more persons are now employed directly and indirectly at sewing than before this wonderful machine came. The same is true of weaving, printing, carpet making, the cotton and woolen manufacture,—in fact, of all branches of industry in which machinery has displaced hand labor. More are employed at better wages, with fewer hours per diem, and the workers are in a condition far improved, morally, socially, every way, than before. The consumption of articles has increased so that the demand is greater, and an infinite number of collateral and new branches of industry has been created, so that the number of persons employed in various avocations through machinery is many fold greater than could have been possible had not machinery been invented. Consider the millions of workers in the railway, telegraph, telephone, in producing machinery, in mining for iron, coal, etc., that machinery has developed. Where there is most machinery there is most industry, least poverty, greatest civilization. Never were so many persons employed at remunerative wages, and never was the condition of the working-classes so exalted as to-day. More progress has been made on these lines since 1800 than

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during the previous eighteen centuries.

Most of the great labor-saving improvements have been opposed on the ground that they were against the interests of labor, but they have all turned out to be labor's and the laborer's best friend. Coaches were supposed to destroy the occupation of the bearers of sedan chairs; railways would ruin the coach interests; the steamboat would deprive boatmen of their labor; the shuttle, spinning-frame and power loom would ruin the business of spinners and weavers; the sewing machine would deprive sewing women of work, and yet, all these have not only lightened human labor, but have given employment to millions more than would have been possible under the old methods.

Mr. Wright accurately states the case in his "Industrial Evolution of the United States," pp. 345-6, "Under the old hand system of labor, or, to use a better term, the domestic system which was displaced when machinery came in and the factory system became fixed, the most demoralized conditions prevailed. Those who believe that the old system was better than the new find something poetic in the idea of the weaver of old England, before spinning machinery was invented, working at his loom in his cottage, with his family about him, and from this reflection fall into the idyllic sentiment that the domestic system surpassed the present. This sentiment has done much to create false impressions as to the results or influence of machinery. Goldsmith's 'Auburn' and Crabbe's 'Village' do not reflect the truest picture of their country's home-life under the domestic system of labor, for the domestic laborer's home, instead of being a poetic one, was very far from the character poetry has given it. Huddled together in his hut, not a cottage, the weaver's family lived and worked, without comfort, convenience, good air, good food, and without much intelligence. Drunkenness and theft made each home the scene of crime and want and disorder. Superstition ruled, and envy swayed the workers. . . The ignorance under the old system added to the squalor of the homes under it, and what all these elements failed to produce in making the hut an actual den, was faithfully performed, in too many instances, by the swine of the family. The reports of the Poor Laws Commissioners of England are truer exponents of conditions than poetry, and show more faithfully the demoralizing agency of pauperism and of all the other evils which are so prolific under the hand system of work."

The condition of the poor and laboring classes in England was better than that of those of any other country, in 1800, but still it was pitiable. One-fifth of the entire population was in the army consuming the product of the industry of the rest. Labor was poorly remunerated. The highest wages of skilled labor was from $4 to $6 a week; of unskilled toil from $3 to $5. The first effect of the new labor-saving machinery was to reduce wages of manufactures one-half. Added to

this the prices of food and clothing increased. Wheat, which, in 1792, was $12 a quarter, rose, in 1801, to $45, nearly four fold. This condition of things reduced the masses of the people of Great Britain to the verge of want, and plunged a multitude into actual beggary. The condition of the women and children among the poor then and now, will show the progress made. In the coal mines, children as young as six years, dragged little carts, laden with coal, from fourteen to sixteen hours daily. Disease killed them early in life. Women, in the absence of machinery to hoist coal to the surface, carried heavy packs of it up long flights of stairs on their backs. Machinery for spinning and weaving had been invented during the latter part of the eighteenth century, but it had not come into general use, and the spinning wheel for spinning wool, flax and cotton was in all homes as late as 1810. But the introduction of machinery did not improve the condition of children. They were employed in factories in great numbers. In 1832 a Parliamentary inquiry showed that the employment of young children had so weakened them that men fit for the army could scarcely be found in the manufacturing districts. They were stunted, diseased, feeble and short-lived, in consequence of their toils in the factories in childhood.

The evils resulting from the unduly prolonged labor of children in factories had attracted the attention which its importance demanded, and had been carefully examined by a committee of the House of Commons. The subject of legislative interference between master and servant was new, and the propriety of such interference was doubted by many. The manufacturers were for the most part strenuous in their opposition. The first Sir Robert Peel, father of the statesman, was a noble exception. He himself had then a thousand children in his employment, and he claimed to know, from his own experience and observation, the urgency of legislative interference. But the unreformed House of Commons was deaf to his entreaties. The evil was too gigantic; the suffering which it caused was too cruel. It was settled then—and the settlement was ere long cordially acquiesced in even by those who had opposed it—that, while grown men could fight their own battles, with their employers, and were to receive no help in doing so, the interests of women and children called for protection at the hands of legislature. An act was passed, in 1833, which prohibited the employment of children under nine; which limited to forty-eight hours weekly for working time of children under thirteen, and to sixty-nine hours weekly that of young persons under eighteen. In 1843 a further limitation was imposed. Females, and those males who were under eighteen, might be employed for eleven hours daily during the three years which followed the passing of the act. Thereafter came a reduction to ten hours, and women were forbidden to work in the mines.

The Illinois statutes now forbid the employment in any factory of labor

of children under the age of fourteen years, and provide that eight hours shall constitute a day's work for women and girls in all factories.

The oppressions and sufferings of young children in mines and factories were inexpressibly horrible. The factories were filled with women and children working long weary hours in polluted atmosphere, standing all day on their feet at their monotonous labor. Under this cheap-labor system a curious inversion of the rules of life took place. Women and children superseded men in the factories, and the domestic concerns of the family were attended to by shiftless men, or, mother and father too, lived on the killing labor of their little children, to the utter destruction of parental affection, and of the last remnants of self-respect. Heart-breaking stories were published in the reports of Parliamentary Commissions—about children so weary from their work that the most inhuman devices were resorted to by their mothers to rouse them in the mornings. Southey, under date of 1833, wrote: "The slave trade is nothing to it. . . Once more I say, 'Cry aloud, and spare not.' These are not times to be silent. Lord Ashley has taken up the Factory Question with all his heart, and with a deep religious sense of duty. If we are to be saved, it will be—I do not say by such men, but for the sake of such men as he is."

In South Staffordshire, according to Lord Ashley's speech in Parliament, it was common for children to begin work at seven years old. "In the West Riding of Yorkshire," he said, "it is not unusual for infants of even five years old to be sent to the pits. Near Oldham children are worked as low as four years old, and in the small collieries, towards the hills, some are so young that they are brought to work in their bed-gowns." This "work" was dragging sledge-tubs, on all fours, through tunnels too low and narrow to admit grown persons. The child had a girdle fixed about its waist, to which the sledge-tub was made fast by a chain. It took nearly twenty years from the first agitation of this subject before these abuses were effectually remedied by act of Parliament. Lord Ashley, Earl of Shaftsbury (1801-1885), devoted his life to successful efforts to abolish the abuses of children's treatment by employers. Labor organizations have had a good effect in producing progress. They were formed in this country as early as 1806. The tailors then organized; the hatters in 1819; the shipwrights in 1822, etc. At the end of the first quarter of the century Robert Owen, in England and in this country, started socialistic movements, and soon after attempts were made to legislate in the interests of labor, especially about 1830, to make ten hours constitute a day's labor. At that time twelve, fourteen, and even sixteen, hours constituted a day's work. April 10, 1840, Martin Van Buren, President, proclaimed the "ten-hour system" in all public establishments. From this time on, for many years, ten hours became the established limits of a working day. Now eight hours is the rule.

Various organizations and orders

in the interests of labor were formed, and later the Knights of Labor, the American Federation of Labor, and the American Railway Union and other organizations have included large numbers of the workingmen of this country. In 1890 there were 150,000 Knights of Labor, 500,000 members of the Federation of Labor, and 150,000 in the American Railway Union in this country, and similar organizations in Europe. There are probably 1,500,000 workingmen in this country belonging to their various organizations, and they have greatly modified legislation, and have much advanced their interests.

The Rev. N. D. Hillis, D. D., eloquently says: "Already our working people enjoy an income three times that of the average German family, perhaps already the most intellectual of all the nations. The higher life has now become possible for our people. Our workers in the iron and steel industry enjoy a daily wage double the income upon which Shakespeare wrote his dramas and Milton his poems. And this increasing prosperity is being accompanied by an increase in education and refinement. In the country thrifty farmers are releasing their boys from the plow and sending them to the academy and college. In the city the foundryman's son excels in scholarship the child of the rich man. And, having freed for study the children and youth of the toilers, property is founding schools in which these youth may become wise and strong, for wealth is losing its selfishness. It is founding libraries and reading-rooms. It is endowing colleges and universities. It is enriching the gallery and museum. In his apocalypse the seer saw heaven with streets as of gold. But gold is also making earth's streets beautiful by increasing leisure, wisdom, happiness and morals."

Never before was social science so studied and applied. The most vigorous minds are studying all social phenomena under their statical and dynamical aspects. Out of these investigations a continually improving social state is being evolved,—a process that was never begun until this century was born. Says McMaster, in his History of the People of the United States: "There can, however, be no doubt that a wonderful amelioration has taken place . . . in the condition of the poor. Their houses were meaner, their food was coarser, their clothing was of commoner stuff, their wages were . . . lower by one-half than at present. A man who performed what would now be called unskilled labor, who sawed wood, who dug ditches, who mended the roads, who mixed mortar, who carried boards to the carpenter and bricks to the mason, or helped to cut hay in the harvest-time, usually received, as the fruit of his daily toil, two shillings. . . . On such a pittance it was only by the strictest economy that a mechanic kept his children from starvation, and himself from jail. In the low and dingy rooms which he called his home were wanting many articles of adornment, and of use, now to be found in the dwellings of the poorest

of his class. Sand sprinkled on the floor did duty as a carpet. There was no glass on his table, there was no china in his cupboard, there were no prints on his wall. What a stove was he did not know; coal he had never seen; matches he had never heard of. Over a fire of fragments of boxes and barrels, which he lit with sparks, struck from a flint, or with live coals brought from a neighbor's hearth, his wife cooked up a rude meal and served it in pewter dishes. He rarely tasted fresh meat as often as once in a week, and paid for it a much higher price than his posterity. Everything, indeed, which ranked as a staple of life, was very costly. Corn stood at three shillings the bushel, wheat at eight and sixpence, an assize of bread was fourpence, a pound of salt pork was tenpence. . . A pair of yellow buckskin or yellow breeches, a checked shirt, a red flannel jacket, a rusty felt hat cocked up at the corners, shoes of neat's-skin set off with huge buckles of brass, and a leathern apron comprised his scanty wardrobe. His sons followed in his footsteps, or were apprenticed to neighboring tradesmen. His daughters went out to service."

Labor has been marvelously lightened within the century, while its recompense has been increased many fold. Its day is shortened, its capacity more than doubled by machinery, and its purchasing power vastly increased; tea, coffee, wheat bread, silk, ribbons, saws, clocks, pins, buttons, carpets, pianos, and scores of articles that were formerly luxuries for the wealthy, are now necessaries to all but the poorest.

The advance of the laboring masses of mankind during the present century is greater than was made during the preceding thousand years, if not greater than during all the years of the Christian era.

SIR CHARLES WHEATSTONE.

[Born 1802. Died 1875.]

The rapid interchange of intelligence between individuals resident in different nations and states in different cities and towns, as well as within many of the great centers of population, which Pro- or Wheatstone really commenced by his telegraphic system; and the splendid results which have wed from the early receipt of news, after it is committed to the telegraphic wires,—have been so velous, that no reasonable person can justly question his title to be ranked among the more distin- hed of our benefactors.

CHAPTER VIII.

LUXURIES OF TRAVEL.

ROADS ALMOST UNKNOWN IN 1800—JOHN L. MACADAM—LOCOMOTION DIFFICULT AND EXPENSIVE—THE FIRST CAB—OMNIBUS—HORSE CAR—STEAM CARRIAGE—ELECTRIC CAR—THE PASSING OF THE HORSE.

THE confederation of coal, steam, and iron for the purpose of improving the means of human locomotion has produced magical results. A hundred years ago, even in the best cities and towns, roads worthy of the name were unknown, while in rural and country places they were but rocky and muddy trails. The art inaugurated by the old Romans in building broad highways from city to city seems to have been forgotten, and it was common for nobility and even royalty to be stalled when journeying from city to city, while the less populated sections of all countries were guiltless of anything resembling a modern road. Occasionally an enterprising city would pave its more frequented streets with bowlders from the seaside. I remember Boston well in that particular in 1830, which must have suggested to Coleridge his de-

CROSSING THE PLAINS IN 1849.

scription of the streets of Cologne, —"pavements fanged with murderous stones,"—but for the most part good roads and streets were yet to be. It therefore seemed a wonderful advance when John L. Macadam (1756-1836), an inventive Scotchman, gave out his idea of "macad-

TROLLEY CARS.

amizing" streets and roads. His theory is one of many illustrations of the old saying, *nil novi sub sole*—"nothing new under the sun," but it was certainly "as good as new," and no doubt it was thought, as the coaches and stages in Great Britain rolled along at the rate of ten miles an hour over smooth and graveled highways, that the *ultima thule* of locomotion had arrived. And it may be confessed that notwithstanding many improvements of paving with stone, or wooden blocks, or bricks, or asphaltum, there is nothing on the whole so cheap, easy for horse and man, comfortable and pleasant, as a well macadamized road. And yet the man who invented or re-invented it in modern times lived in more than a third of the present century!

Moreover, Macadam's scheme created no change in the method of travel. Carriages drawn by horses were used alike by prince and pauper, and there had been no real improvement for a thousand years, when the railroad sprang into being, and the locomotive and the sumptuous train conveyed the poorest traveler as no king had ever been able to journey. Methods of travel have improved more within a century than in all preceding time since the first horse was harnessed.

The roads built by the Romans in Gaul were like those of Macadam. Indeed, something very like them had long been in use in China, and it has been charged by those who like to believe that every modern improvement is a "lost art" rediscovered, that Macadam obtained his idea from reading accounts of Chinese roads. But as thousands of others read the same accounts and he alone took the hint, it is proper that "macadamize" should be a word securely lodged in the usage of mankind.

At the beginning of this century

AN AUTOMOBILE OR HORSELESS CARRIAGE.

commerce was paralyzed by lack of means of transportation. "It cost forty shillings to transport a ton of coals from Liverpool to Manchester. Men could not travel in England, without considerable personal danger, owing to the condition of the roads. During the winter months

traveling was generally impossible. The food of London was for the most part carried on pack-horses. Often the large towns endured famine, while the farmers at no great distance could find no market for their meat and grain. Communication between London and Glasgow was maintained by a stage-coach, which undertook this great enterprise only once in a month, and accomplished it in twelve or fourteen days. The seclusion resulting from the absence of roads rendered it necessary that every little community, in some measure every family, should produce all that it required to consume. The peasant raised his own food. He grew his own flax or wool; his wife or daughter spun it, and a neighbor wove it into cloth. He learned to extract dyes from plants which grew near his cottage. He required to be independent of the external world, from which he was effectively shut out. Commerce was impossible until men could find the means of transferring commodities to the place where there were people willing to make use of them."

Four months were occupied between St. Louis and New Orleans, by flat boat, and weary weeks were consumed in wagon journeys with produce, so that the farmer's labor brought him but small returns. It took three months—from November to February—for the people of Kentucky to hear of Madison's election to the Presidency. Franklin was four days in the coach from Philadelphia to New York.

The first great public improvement in this country was the Cumberland Road, projected in 1806 from Maryland to the Mississippi, and prospectively to the Pacific. The war of 1812 arrested it after it reached Indiana. In the beginning of the century came the era of turnpikes, and with them fine coaches and comparatively rapid transit. Eight hundred coaches arrived and as many left Boston every week, in 1827. Previous to the turnpike most carriages were two-wheeled, chaises and sulkies, etc. But there were no bridges across the great rivers, and passengers by stage, and private carriages, were ferried across rivers.

Many and various have been the changes since the century came in. When Washington left his home at Mount Vernon, April 16, 1789, to go to New York, the temporary capital, where his inauguration was to be held, he made the journey by carriage. In the early days of this century travelers went from one town to another in various ways. People of means rode in carriages or in light two-wheeled vehicles, crossing the rivers in large scows, although frequently it became necessary to swim the horses over and float the carriages at the stern of the canoe. Sometimes two canoes were put side by side and lashed together so that the horses might place their fore feet in one boat and their hind feet in the other, and in that way be ferried across the stream. Perhaps the most comfortable mode of travel was that of riding horseback, and often two people journeyed with but one horse. The first rode ahead and tied the horse by the road; the second, when he came up, rode on

past his companion and in turn tied the horse and left him for the other. This was called "traveling, ride and tie." One of the commonest modes of traveling long distances was by sailing packets and the trip from Albany to New York generally consumed several days. Rude wagons were run between the larger towns, and it took six days to go from Boston to New York, and three days to go from New York to Philadelphia. The interior trade was carried on in great wagons, drawn by six or eight horses, and in remote districts of the country by pack horses and small boats. Mails were carried mostly on horseback, so that by the time a letter reached its destination the news sent had become history.

The projector of the English mail coach was John Palmer (1742-1818). Rubber tires for carriage wheels was an invention of the *fin de siecle*, the Nineteenth. The first cab appeared in London in 1823, introduced from France; the first hansom cab in 1834. The omnibus originated in Paris in 1827, and was introduced in London in 1829, and in Amsterdam in 1839. Once the most popular public conveyance, it is now obsolescent, and is rapidly becoming obsolete. Four-wheeled wagons were not common in this country until 1812. Two-wheeled carts and sleds were chiefly used. The pleasure carriage is a recent achievement. Obadiah Elliott, in 1804, invented the first eliptic carriage spring, and the chaise, the phaeton, the buggy, the gig, etc., followed. Made by hand they were very expensive, but when machinery produced them they became cheap, and now every style of pleasure carriage is within easy reach.

Town and city was supposed to be and was wonderfully improved by the horse car, a vehicle so rapidly passing into oblivion that most of the next generation will never see one. The first street railroad was in this country in 1850—in 1813 in New York, but the institution was not general until 1850 in America—in England in 1860. Horses, of course, were the motive power. In 1859 stationary engines were employed.

In 1873, in San Francisco, Cal., Andrie S. Hallidie was distressed at seeing the horses hauling the street cars up the steep hills in that city, and in struggling for a substitute he evolved the cable car system. The motive power is a wire cable, forming an endless belt, that is dragged through a subterranean channel, over pulleys by powerful stationary engines at some point along the line, generally where two loops of the road meet. The cable, by reason of its great weight and liability to accident, is divided into sections (each consisting of an endless belt). This road ascends the steepest grades as easily as it follows levels; the cars can be instantly started and stopped; the speed is uniform, and snow does not blockade it. But it is comparatively expensive, and it is giving way to the electric car, which is now being rapidly introduced, even in smaller cities and towns, and which is superseding the locomotive even on railways between cities. Indeed

it looks as if the days of the locomotive were numbered. (See "Electricity.") The first electric trolley was built by Chas. W. Siemens (1823-1883) and Halske in Germany, in 1881.

Since the advent of railways tunnels have been excavated through hills and mountains, some of them of great length. There are now hundreds of them. Some of the most stupendous efforts of man have been put forth in excavating the earth. One of the first and greatest of such works is the Mons Cenis Tunnel. It was commenced at both ends in 1857, and with an engine and machinery worked by compressed air, the Sommeiler boring machine, the work was accomplished in 1870, thirteen years. Only manual labor, however, was employed until 1861, after which the bore advanced eighteen inches a day, until 1862, when it increased to three feet nine inches a day. The length of the tunnel is about eight miles. It cost $15,000,000. The St. Gothard Tunnel, nine and a half miles long, cost $7,300,000. The Simplon, to be completed in 1904, will be twelve miles in length, directly under the Kaltwasser Glacier, and will cost about 55,000,000 francs. The Hoosac Tunnel, only five miles, cost $16,000,000. The latter was bored before the great borers were invented. Innumerable others all over the world are all the work of this century. Brunel was the engineer of the Thames Tunnel, which was from 1823 to 1843 in building. It cost $31,000,000. Brunel is said to have also suggested the first screw propeller. The process of rock boring for tunnels, canals, etc., has been wonderfully facilitated by machines of recent invention. The hardest rock is pierced by the diamond drill, a black Brazilian diamond, or "carbonado," which is inserted on the point of a steel drill. Hundreds of feet are penetrated without wearing the diamond. The Sommeiller, Burleigh, Bartlett, and other borers accomplish in days the work of months by ancient methods. Other inventions easily bore through soft clay and sand.

The latter part of the century witnesses a great variety of motors. Not only steam, but oil, naphtha, electricity, and compressed air are applied to vessels in water and vehicles on land. Pleasure carriages, business carts, plows, cycles, wheels, mills, all sorts of machinery are moved in all sorts of ways. The mountain streams and rivers and the waves of the ocean are made to produce electricity and to work for man. Our predecessors would be amazed, should they "revisit the pale glimpses of the moon," to see horseless vehicles, moving with no motive power apparent, and possibly our posterity may smile at our boasted superiority, as they shall flit in the air in aerial ships, or go to and fro on wings or their substitutes, as now we limp about on our wheels, or clumsily move in horseless carriages, or railway coaches tied down to iron rails. (See "Electricity.")

How dignitaries fared *en route* a century ago may be learned from President Quincy, of Harvard Col-

lege, who describes his journey from Boston to New York at the end of the last century: "The carriages were old, and the shackling and much of the harness made of ropes. One pair of horses carried us eighteen miles. We generally reached our resting-place for the night, if no accident intervened, at ten o'clock, and after a frugal supper went to bed with a notice that we should be called at three next morning, which generally proved to be half-past two, and then, whether it snowed or rained, the traveler must rise and make ready, by the help of a horn lantern and a farthing candle, and proceed on his way over bad roads, some times getting out to help the coachman lift the coach out of a quagmire or rut, and arrived in New York after a week's hard traveling." In 1796 it took five days to go between Philadelphia and Baltimore. Early in the century, however, a great improvement was made. Fine turnpikes were built, and greatly improved coaches appeared. But now hours accomplish what days could not, and luxury everywhere has succeeded hardship in travel.

The middle of the year 1899 witnessed the advent of the horseless carriage in great numbers. Nearly $400,000,000 are already invested in its manufacture. Cabs, delivery wagons, trucks, pleasure carriages of many kinds are seen in all large cities, and it is to be the vehicle of the twentieth century. Six different motive powers are now moving them — electricity, gasoline, steam, carbonic acid gas, compressed air and alcohol. It is easily handled, economical, can go in all weather, can be turned in small space, and is safer than the horse carriage; never runs away, and is certain to be the popular carriage of the twentieth century.

The latest agent of locomotion is the Æodrome, invented by S. P. Langley, of Washington, D. C. The inventor claims that it will carry six men, and travel 100 miles an hour. It is made of aluminum. The engine is operated by liquid air. The sails are modeled after the wings of the albatross. The new gas, coronium, is utilized in buoying up this flying machine. Though too early to announce the entire success of the Æodrome, yet it may be prophesied that America may, before the new century is born, give to the world its first machine to sail in the air. Nikola Tesla recently stated that this invention was certain to be perfected; and those who know Professor Langley are positive that he is the one man in a million to perform the miracle.

The automobile prophesies the passing of the horse. Thaddeus Horton, in Collier's Weekly, gives a hint of what awaits the noble animal, and the advantage to him and to society when he shall have taken his long rest. "Cobble pavements are made to resist metal tires and the pounding of steel-shod horses. With every vehicle motor-driven, and every wheel pneumatic-tired, all pavements can be of asphalt. Not only will the rumbling of heavy trucks and the clatter of hoof-beats disappear, but there will be no more trucks to cut up the streets, since electric

omnibuses, carrying as many people and moving as swiftly as the electric cars of to-day, will take the place of street railways. Having already conquered the rail, electricity will then have made itself master of the highway as well. Rapid transit for long distances being supplied by electric trains in clean, cool, brilliantly-lighted subways, the elevated roads will be no more. The removal of the horse from the streets will not only make them noiseless, but will practically solve the problem of street-cleaning, and greatly improve the sanitary conditions of urban life, reducing the amount of street refuse to a minimum. With clean, smooth thoroughfares, through which swift, air-shod, easy-riding vehicles dart noiselessly, it will no longer be necessary to seek the country for rest and quiet.

"Once the horseless age is in full sway, every man will have his own automobile, and the bicycle, which has already, to some extent, supplanted the horse, will in turn be shelved, save for purposes of sport. With the universal development of sources of supply of electricity, the electromobile will take the place of all other forms of traction, and plugs will be provided in the streets from which the automobilist may take his supply of power by a nickel-in-the-slot device, while along rural highways power stations will be established so that journeys of any distance may be undertaken. Even on the farms autowains will do the heavy burden carrying. The horse may still be harnessed to the plow, may still furnish sport on the race-course, and riding exercise for the few, but no longer will he be the chief bearer of man's burdens. Who will say he has not earned his rest?"

Those in middle life can see a marvelous progress during their own life-time in the speed and comfort of traveling, and those who are beyond the allotted three-score realize the difference still more, while the contrast between the beginning of the century and its close is little less than magical. The difference is illustrated by the fact that "the Forty-niners" occupied five months in reaching the Pacific coast via the Santa Fé trail, while the distance is now accomplished in three days by the Santa Fé Flier, and the traveler scarcely knows that he is journeying.

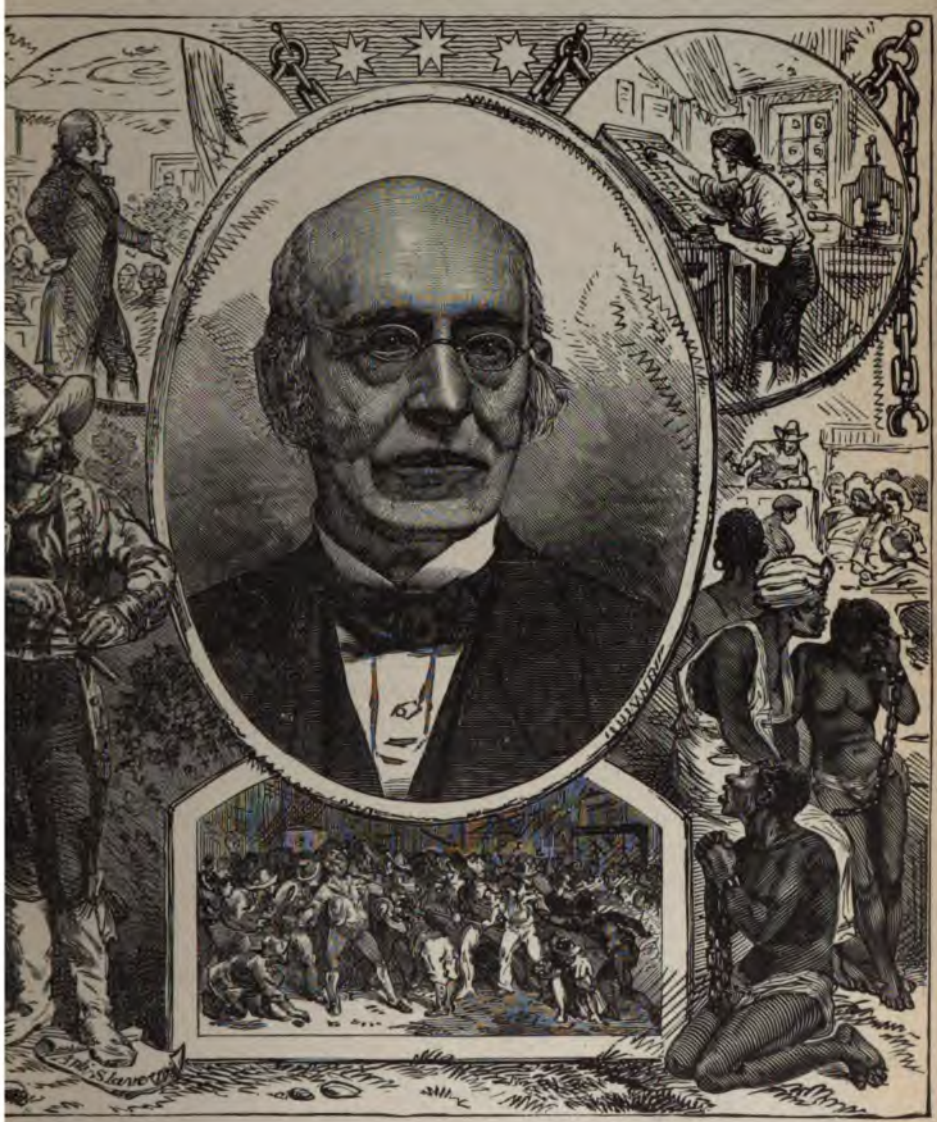
One of the most interesting of studies is to be had in any of the great depositories of the monuments of human achievement. No department of Anthropology affords more striking proofs of man's genius than those to be found in his methods of locomotion. The dug-out, the boat of animal skin, the rude canoe, the sail-boat, the ship, the steamboat on the water; and on the land, the wheel, the skate, the horse, the many kinds of vehicle, the carriage propelled by steam or gasoline, or electricity, and last of all the horseless carriage, the latest triumph of man in overcoming obstacles—all these demonstrate his supremacy over time and space.

What shall be man's next step of advance? Who can tell? The writer consigns the answer to this question to his successor in chronicling man's great deeds, when he shall record

the wonders of the Twentieth Century. One thing is certain: the end of improvement is not yet. There are those, it is true, who think that the future will not yield as much as the past has done, but man is a progressive being, and will remain such in all the centuries to come. He has already erased the word "impossible" from his vocabulary, and one by one the conveyances of the past and present will give way to improved methods of locomotion. To one who shall occupy the vantage ground of the thirtieth century, all our boasted means of traveling may seem to have vanished in a moment. Unlike the "deacon's one-hoss shay," they will seem to him to have been full of "weak spots," and to have dissolved like the "unsubstantial pageant of a dream.'

WILLIAM LLOYD GARRISON.

[Born 1804. Died 1879.]



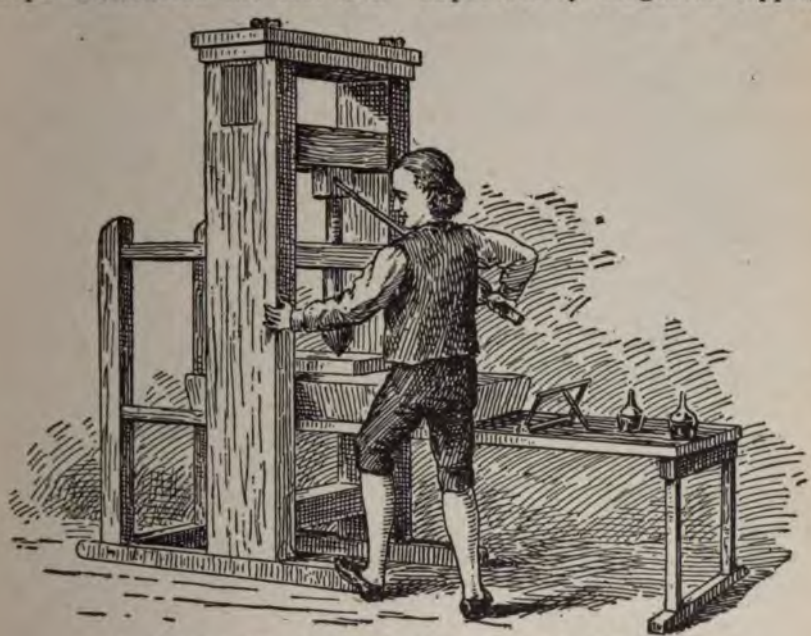
William Lloyd Garrison was intensely a man of peace. He had always condemned physical violence, would never allow it to be resorted to on his behalf. He would have left nothing undone to have rated the slaves without it; but the slaveholders themselves ruled that such was not to be. Soon r the close of the war Garrison made a tour through some of the Southern States; and on more one occasion he had the inexpressible pleasure of addressing large audiences from the auction k, never more to be desecrated again for the vile purposes of slavery.

CHAPTER IX.

PRINTING.

IN 1800 TYPE WAS HAND-SET AND PRINTING WAS DONE ON HAND PRESSES—FIRST POWER PRESS, 1807-11—THE GREAT HOE PRESS—THE STEAM PRESS—FRIEDRICH KOENIG—THE LINEOTYPE—OTTMAN MERGENTHALER.

UNTIL this century came in, all type was set by hand, and all printing was done by clumsy wooden hand-presses that were not unlike cheese-presses. In 1798 Earl Stanhope constructed the first iron (hand) press. Close after it came that tremendous engine of progress, the power press. The inventor was Friedrich Koenig (1775-1833), aided by Bauer. Koenig made the first crude suggestion of his great invention in London, England, in 1807, and set the first one in operation in 1811. Previously Adam Parkinson, in 1805, had patented the idea of the cylinder, which was further improved by Augustus Applegath (1790-1871) in 1813, and by James Thomson (1815) and Edward Cowper (1790-1852). This was the rotary press. Abner C. Goodale (1805-1898) later invented the process of printing both sides of the



A TYPE OF PRESS USED IN THE EARLY PART OF THE CENTURY.

sheet in one operation. (Goodale also invented the cracker machine and perfected the preparation of copper and steel plates for use by engravers.) Koenig's press had sixty wheels; Augustus Applegath reduced it to sixteen, and later it was reduced to six. Further improvements were made by Koenig in 1813-1814. Conservative printers regarded the new machine as a "gimcrack," but John Walter (1784-1847), of the London Times, adopted it, and November 29, 1814, the first newspaper was printed by the steam power press. When first employed the sullen pressmen stood around ready to destroy it. Koenig and his coadjutor Bauer were both Saxon Germans. It is sad to say they derived no advantage from their invention, and left England in disgust in 1817.

Before 1814 only 200 impressions an hour were taken by the hand press on one side only. Koenig was able to make 1,100. Applegath and Cowper, by their four-cylinder machine, produced 4,000 an hour, and by the eight-cylinder machine 10,000 an hour were printed, but these were only on one side.

The Bullock, the Brahma (Joseph 1748-1814), the Walter, the Adams (1802-1883), Power (1830), the Hoe (1840), and other perfecting presses take the roll of paper through the press, print both sides, cut off and fold the sheets. Bensley's was the first machine for inking, followed by Cowper's. Improvements have been made by Walter, Bacon, Donkin, Brightley, Winch, Cooper, Miller, Congreve, Ruth Bold, Spotiswoode, Parkins, Hanserd, Delcambre, etc.

In 1834 the first steam printing press was introduced into New York City. The most rapid pressmen could not pull impressions enough to meet the morning call. One of the New York papers now claims a daily average circulation of 820,000, and a Sunday average circulation of 680,000; and that the presswork is accomplished by "three great octuple presses, the largest ever made, added to a press equipment now unequaled in any daily newspaper office on earth; being the equivalent of fifty-seven single presses, designed for an output of 744,000 eight-page papers per hour."

The daily paper is now produced by a steam rotary press. The type is set by machinery, in a cylinder, stereotyped, and the paper is on a roll, which, as the press is moved, is cut off the requisite size and automatically inked, printed, and folded, and the whole paper is produced with almost no human intervention. Hoe's double cylinder machine, invented in 1840 by Richard M. Hoe, of New York (1812-1886), has from two to ten impression cylinders, which print so many sheets at the same time. The newspaper press takes the paper from the roll, prints from stereotype plates, and cuts, pastes, and folds 10,000 to 12,000 18-page newspapers an hour. Among a multitude of modern presses, only a few need here be named: Cottrell's Improved 2-Column Press, Hoe's Century Press, Novel Press, Hoe's Prudential, 2-Revolution, Stop-Cylinder, Hoe's Octuple, etc. Hoe's Rotary Art Press produces work equal to the best hand presswork.

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force of the time. The
rapid printing press, by making the newspaper possible, deserves to rank as one of the great achievements in an age of mechanical invention. Certainly there is no other machine of such power and complexity that possesses at the same time such accuracy and delicacy, handling, printing, and folding sheets of paper that can be torn between the fingers without an effort. "The latest octuple press," writes Mr. R. Hoe, the great manufacturer, "is composed of about 16,000 separate pieces and requires eighteen months for its construction in the largest manufactory in the country. It is more complicated than a locomotive or a watch, or any of the forms of mechanism to which we ordinarily refer as remarkable for their intricacy or nicety.

"This press is fed from three continuous rolls of paper, each more than five feet wide and all reeling off the paper as fast as it will run without tearing. At its highest speed the press will use up over two miles of this paper in an hour, or fifty miles of paper of the width of an ordinary newspaper page.

"In terms more readily grasped, this indicates a capacity of 96,000 four, six, or eight page papers per hour. Not only are these papers printed at this astounding rate, but they are also cut, folded, and counted.

"In other words, the press performs every operation connected with the paper from the time the rolls are put into position until the finished product emerges ready to be put on sale. Ninety thousand papers per hour means 1,500 per minute, or

twenty-five copies for every second ticked off on your watch.

"Most of the larger newspapers have in their ordinary issues ten or twelve pages. Of these the press will turn out 72,000 in an hour, 1,200 to the minute, or 20 every second.

"The machine weighs over sixty tons and is massive in its proportions. Yet its touch is as deft as that of human fingers. It handles the papers accurately, cuts them precisely and folds them up evenly, all with speed that is well-nigh incredible.

"Its operation is easy and resistless. A man throws back a lever, the many shafts and cylinders begin to revolve, going faster and faster until the streams of white paper are pouring into the machine too rapidly for the eye to measure. On the other side the printed sheets rain out so fast that one sees only the continual flash of the steel fingers that seize and forward every sheet.

"The operation of the press at its highest rate of speed means that each paper receives its impression in less than one-fifth of a second. How a permanent imprint can be made in that space of time is a marvel difficult to comprehend. Yet it is done. The ink does not smut nor rub off, and even the most delicate lines of an illustration are accurately reproduced."

As lately as 1865, it required twenty-six men and boys to print and fold 25,000 eight-page papers an hour. Now four men do four times the work in the same time. What a contrast between the newspaper of to-day and the penny four-page sheet of a century ago. Not a telegram, not an interview, not an illustration, except a small picture of a runaway negro, or of a sailing vessel at the head of shipping news, then appeared. It was carried by horseback, or by stage, once a week, and with what avidity was its meagre bill of fare scanned. Poor as it was, it was greedily devoured. Perhaps the most striking contrast in the Philadelphia Exhibition of 1876 was the press at which Benjamin Franklin once labored, and near it the Walter machine, throwing off its hourly 17,000 copies of a newspaper.

Says Mr. Hoe: "The latest innovations have been in connection with color printing, which has required the addition of more new parts to the mechanism of the machine. A single color press, built last year for one of the largest dailies in the country, contained between 50,000 and 60,000 individual parts. It seems as though this was carrying the possibilities of one machine to its utmost limits, but it is by no means certain that still further additions may not be made.

"Such machines as this cannot be constructed without great expense. The price of the most improved style of quadruple machine is $35,000, of a sextuple, $45,000, and so on, the price mounting with the complexity of the press itself and the increase in the work it is intended to do. In the best equipped newspaper office in the country the value of its machinery employed falls little short of $1,000,000.

"From the webb press of 1871 to

the latest improved form described at the beginning of this article, with its speed of 96,000 per hour, there has been no radical change of style or form. The improvements have been in matters of detail and in the direction of an increased size and capacity. Even at the present time no thoughtful man would venture to say that the limit of speed had been reached. In the future our successors may smile at the designation of a press which prints less than 100,000 papers per hour and with cylinders revolving 200 times to the minute as 'rapid.' Nevertheless, by our present standards it is rapid, and its construction deserves to rank among the great achievements of the century."

The various typesetting machines are wonderful pieces of mechanism, wholly the work of the last few years, and are rapidly revolutionizing the process of printing. Great rapidity and accuracy are automatically accomplished at a cost far below handwork. Only within a very short time have machines been produced equal to the demands of the great newspapers. It seems impossible that type should be rapidly set—"composed"—by machinery, though so-called "dreamers" had long pondered the problem. Early inventions, most of them impracticable, were made by William Church, 1822; the first American by Adrienne Delcambre in 1841; then Dickinson's, Lorenz's, Westcott's, 1871; etc. Between 1841 and 1875, seventy-two patents were entered.

The Linotype enables an operator, by means of a keyboard, to set lines of type of any length, which are then cast as solid lines, and dropped into a galley, while the following line is being set and justified. It has a keyboard of 107 keys, enough for the ordinary types of one font. It is operated by a series of female type, or matrices, which are arranged in the channels of a magazine, with escapement devices connected with finger keys. As these matrices are called out, they move on a traveling belt, and are arranged in line. A lever is depressed, and the matrices are transferred to the face of a mold, and melted metal is made to flow into the mold, and thus a bar of "linotype" is cast and ejected. Then the matrices are transferred to a distributing machine and automatically distributed—8,000 or 10,000 ems an hour is the capacity of the Linotype. The Linotype originated in the brain of Ottmar Mergenthaler. He was born in Germany in 1854, and migrated to this country at the age of eighteen. He invented and completed the first machine in 1877, when he was but twenty-three, and in 1879 he sold his interest in the machine for $60,000. The parties to whom he sold formed a syndicate with $300,000 capital, which was watered to $10,000,000, on which there has been twenty per cent. annual profit. Mr. Mergenthaler himself has realized but a small return for his ingenuity, while shrewd business men have been enriched. One linotype performs the work of many men.

The Thorne Typesetting machine sets the type and automatically distributes it, after it has been used, back into the machine for use. A keyboard and two vertical cylinders,

both cut with vertical grooves, receive the type, which is first distributed and then set. There are ninety grooves in each cylinder, enough to contain all the characters used in printing. A key corresponds to each character, and on being pressed places it in position. Each type is grooved, like the wards of a key, so as to fall only into its proper place. This is in the lower cylinder. The upper cylinder revolves, and the type is fed into it, a line at a time, until every groove is filled, and the upper cylinder revolves upon the lower. As the columns of mixed type pass the grooves in the lower cylinder each letter falls into the groove into whose ward its nicks fit.

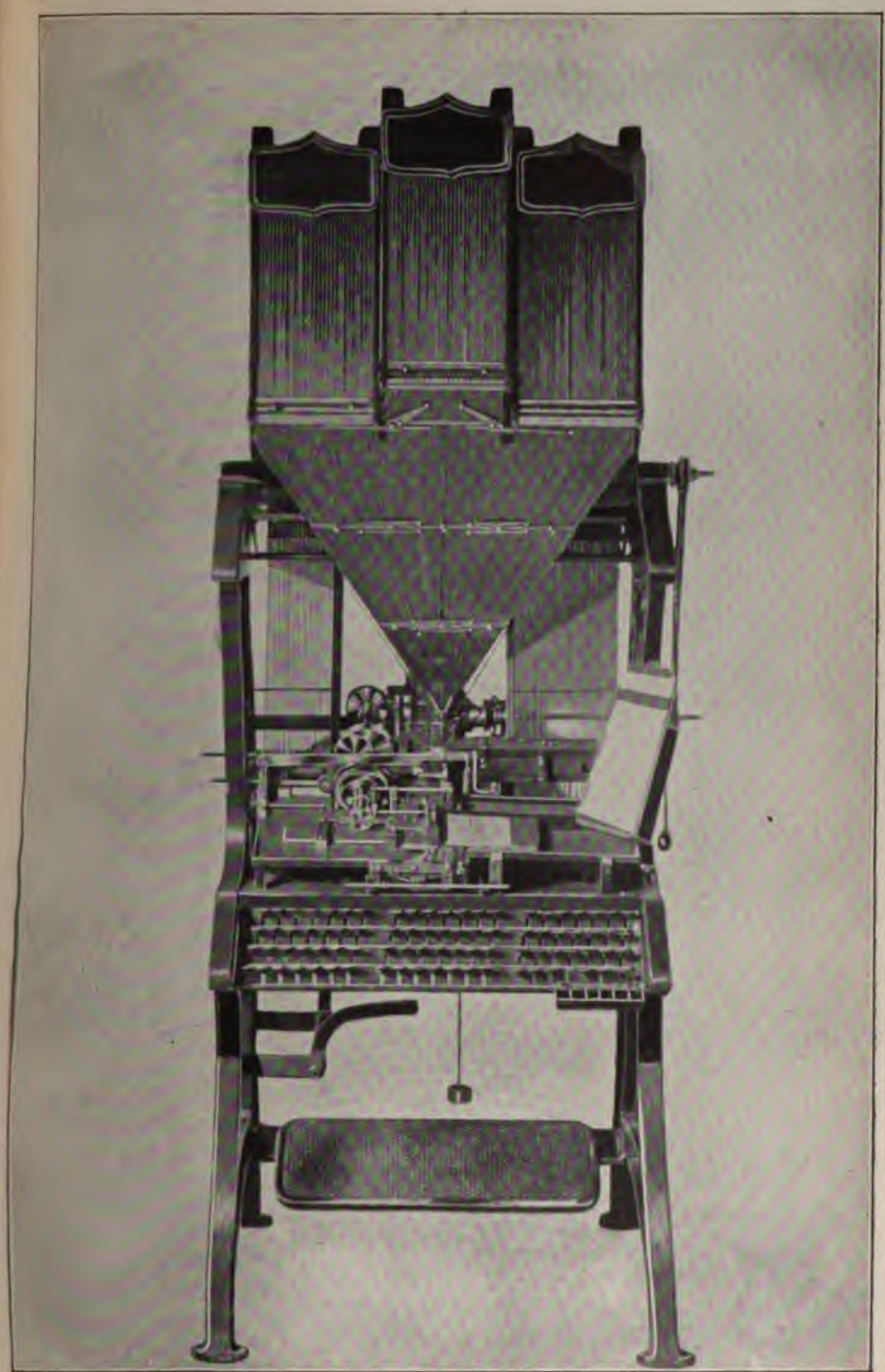
In the Empire machine each type has its individual nick, but is distributed by a separate machine into grooved cases. The typesetting machine is operated by a keyboard, and the type, when liberated, falls into a track, where it is justified to the proper measure.

The Lanston Type machine is the invention of Tolbert Lanston. The type-caster and compositor are combined in one process, the metal being transferred from the crucible to the galley in composed type ready for the press. The keyboard contains 225 keys. By these machines one and one-eighth persons perform the labor of eight. The Lanston keys are operated by electricity.

The Rogers Typograph, the Munson method of type composition, the Lee-Muckey Electric Linotype machine, and others are in use. The Electric Linotype employs male or cameo characters at the ends of bars. The bars are released by electromagnets, operated from a keyboard, and when a line is completed it is automatically clamped, and then pressed against a soft lead bar so that it receives the print of the line, which then receives the moulten metal, and the type is cast. The Rogers Typograph will "set" a newspaper at a cost of $67.00 that would by hand cost $173.00. It can set 7,000 or 8,000 ems an hour.

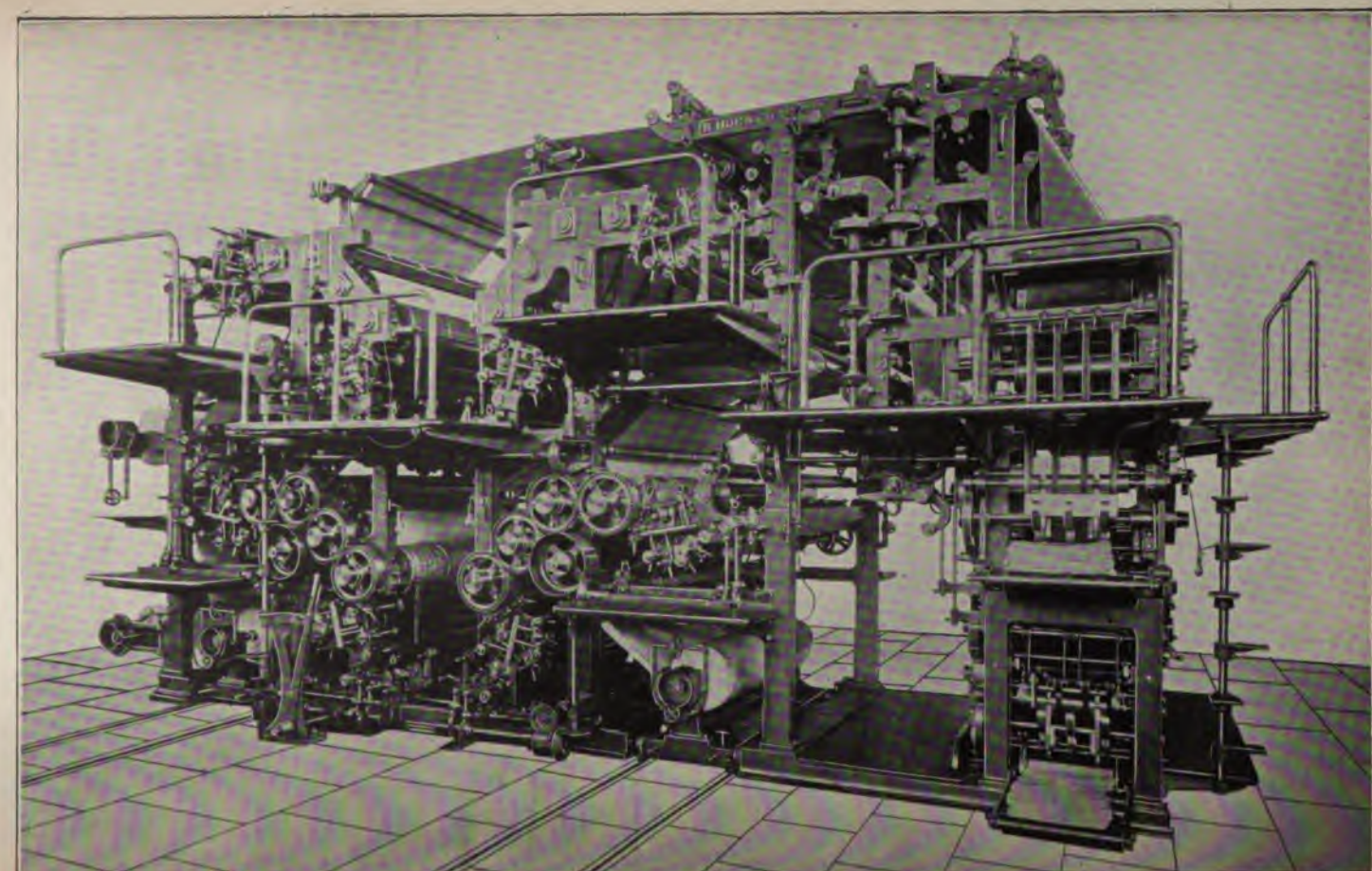
At the beginning of the century all paper was made from rags, and in small sheets. The pulp was dipped from the vat in a hand sieve, and laid upon a sheet of pasteboard, and another sheet of pasteboard laid upon it, and more pulp on that, and so on, until a sufficient number of sheets were piled up to fill the press; when the water was squeezed out and the sheets were dried. This process was improved upon until the Fourdrinier machine came, by which two or three attendants can make more paper in a day than hundreds did by the old hand process. The inventor was Louis Roberts, whose machine was perfected by Bryan Donkin and John Wilke. Huge rolls are produced for the newspaper press. Roofs are covered by paper, and all sorts of articles, such as barrels, tubs, pails, etc., are made.

The century, too, has discovered that waste paper, straw, wood, the stalks of Indian corn, grass, cane and various vegetable material can become paper, a lesson the wasp and hornet were all the time teaching, but it took thousands of years for the slow scholar, man, to learn the trick of converting wood to paper.



A TYPE-SETTING MACHINE.

"Type-setting machines are rapidly revolutionizing the process of printing."



AN OCTUPLE PRINTING-PRESS.

The machine for folding paper was invented by J. S. Gallaher in 1843.

Stereotyping consists of taking castings of type set up, and of cuts, so that the original plates and the type may not be injured, and the type distributed for further use. Plaster of Paris, clay, or *papier mache* is the material in which the mould or matrix is made. Wilson, of Scotland, invented the present stereotype process in 1823. William Ged, in 1731, had a rude suggestion of the process.

Electrotyping is a similar process. A mould of the type is taken in wax and hung between the positive and negative poles of a battery, in a solution of sulphate of copper, when a thin sheet of copper is precipitated upon the surface of the wax. The thin sheet is then backed by type metal and mounted on wood, so that the pages, or forms, are as thick as the length of ordinary type. Electrotyping was perfected on the discoveries of Volta, Cruickshank and Wollaston, in 1800-01. In 1838 Spencer made casts of coins; in 1839-41 Joseph A. Adams, of New York, black-leaded stereotypes and Silas P. Knight, of Harper Brothers', coated the mould with graphite. Since then the art has made great progress. Thus, while the original type can be used over and over the forms can be used in repeated editions.

TYPE-MAKING MACHINE.

The facility and rapidity of travel and of telegraphic and telephonic communication has created a tremendous thirst for news, and the demand has compelled enormous enterprise in furnishing the supply. At the beginning of the century a comparatively few weekly newspapers of small size answered all demands. Now weekly papers are published in the smallest villages and morning and evening dailies issue enormous editions in small as well as large cities. An important event occurring to-day in London is telegraphed to Chicago and appears in an "extra" several hours before it starts, making allowance for the difference in time; and the daily containing twenty pages is furnished for two cents, or even one cent, and the Sunday edition, a volume of literature, news and miscellaneous matter, is sold for a nickel.

The rapidity of production, cheapness, size and excellence of periodical literature, compared with a hundred, or even fifty, years ago, is one of the most astonishing of all the modern advances.

It took three days to carry the dispatches of Waterloo to England, where they were printed in newspapers and conveyed on horseback, or by mail coach, over the rough roads to all parts of the kingdom. It was weeks before all the people had learned of that victory, which settled the fate of Europe.

Newspapers, letters and people were carried by mail coaches or on horseback, and it was not till a third of the century had gone that decent roads were built, so that the mail coach could be used, and on the sea it was no better. Steam was not, and the clumsy models of ships crossed the Atlantic in from one month to three months, according to wind and weather. Improvements in printing and in the circulation of news has kept pace with the other wonderful improvements of the century.

Aloys Senefelder (1771-1834) invented the art of lithography in 1800, or soon after. He was indebted to an accident for his discovery. He was a musician, and was accustomed to record his music on thin sheets of limestone. One day a sheet fell into a bucket of greasy water, and he observed that the grease adhered to the notes, while the rest of the stone was clean. From this simple incident he thought out his great invention. Though he tried to keep it secret, it leaked out, so that the inventor reaped little profit. The process is to highly polish certain kinds of stone, on the surface of which the design is drawn, when nitric acid and gum are poured on and the parts not protected by the ink or crayon are eaten away, leaving the picture, or characters, to be printed. Chromo lithography reproduces pictures in colors, as many stones as colors are required, and in such a picture as Murillo's "Immaculate Conception," for example, by Prang, of Boston, thirty or more stones are required, so that the process of producing a single picture requires months. But as thousands of copies are sure to be disposed of the price is reduced to a low figure, while the effect is scarcely inferior to that of the great original. Similar effects are produced by a series of wooden blocks, each with a differently colored ink.

Among the great masters of lithography are Senefelder (1771-1834), J. L. T. A. Gericault (1791-1824), Bonington, J. D. Harding (1798-1863), E. L. G. Isabey (1804-1886), Calamne, F. V. E. Delacroix (1799-1863), Daumier, Charlet, Deveria, Raffet, and P. C. Gavarni (1801-1866).

Alex. Anderson (1775-1870) was the first engraver in America.

Photo-lithography is the transference to stone of a photograph. A sheet of paper is prepared by coating one side with a viscid solution, consisting of a mixture of albumen, gelatine, and bichromate of potash; this, after being dried in the dark, is exposed under a negative of the original to be reproduced. The photographic positive picture, thus obtained, is inked all over while dry by pulling it through the press face down, in contact with a lithographic stone to which an even coating of transfer ink has been applied.

When the sheet is removed from the stone, the adhesive ink covers its surface, and nearly conceals the underlying photographic picture below it. This sheet is next placed floating on hot water, with the inked side upwards; the moisture and heat together effect a coagulation of the albumen in the compound organic film, while the gelatine portion of the same gelatinizes and swells. The sheet is now lifted from the water, laid flat on a slab, and friction applied to its inked surface by means of a wet sponge. The superfluous ink not needed to form the transferable picture is hereby removed; the sheet is flooded with abundance of warm water, dried, damped again slightly, and transferred to stone by simply inverting it thereon and pulling it through the press the usual way. When removed, the ink on the surface of the transfer sheet will be found to have passed over to the stone, which is then rolled up and etched, after which it is ready for the printer.

Besides zinc etchings, nature engraving, etc., there are other methods of engraving, the last, and so far the most valuable, of which are photogravure and half-tones.

John Sartain (1808-1897), famous artist, engraver and critic, was engraver par excellence, and some of the works of his hands are familiar to everyone who has looked into the windows of picture stores, and to many who have never been off the farms they were born upon. At fourteen he began to learn engraving, and at the end of a year he was so proficient that he was intrusted with most important work. He became exceedingly adept in the practice of mezzo-tinting, and brought that art to the United States in 1830. In 1843 Mr. Sartain brought out Campbell's Foreign Semi-monthly Magazine, and turned editor. Meanwhile he continued his profession of engraving and established Sartain's Magazine in New York. His most noted plates are "Christ Rejected," "The Ironworker," "King Solomon," "Civil War in Missouri," "Homestead of Henry Clay," and "The Battle of Gettysburg." For sixty-seven years he lived in Philadelphia and was one of its most honored citizens.

Nature Printing is the invention of A. Auer, of Austria (1778-1814), improved by H. Bradbury, of England. Plants are imbedded in soft lead plates, which, when electrotyped, become types of the leaves or flowers, like copper plates.

The Woodbury process bears the name of the inventor. It is a counterpart of a photograph, which is produced on the plate, by causing the photograph to engrave its own image, with all the details of the original picture.

Zincography, half-tones, and other processes, have brought the art of illustration to a degree of perfection that was not deemed possible by our ancestors.

The Graphotype is produced by sifting the finest chalk on a metal plate, and subjecting the chalk to hydraulic pressure. Then the design is drawn on the smooth chalk surface. When the ink is dry the surface is brushed until all the chalk

unprotected by the ink is removed. Then a solution of silicate of potash is poured on the chalk, which becomes stone. From this a mould is taken, and a stereotype plate obtained.

Autotypography is a process invented by Wallis, by which drawings made on gelatine can be transferred to soft metallic plates, and afterward used for printing from, like ordinary copper plates.

All sorts of new printing processes are being constantly invented.

Anastatic printing is a method of zincography invented by Wood in 1841, designed to reproduce drawings, engravings, printed matter, etc., whether recent or old. If, for instance, it be sought to obtain the fac-simile of an old newspaper, the paper is first wetted with dilute phosphoric acid, and then placed between sheets of blotting-paper to remove the superfluous moisture. It is then found that the acid has corroded the blanks, but has not affected the printed letters. The sheet is next placed in contact with a plate, and pressure applied, which makes a fac-simile of the letters in reverse order on the plate. Gum is next applied, and more ink, then a little acid, and finally again ink, when the printing stands out as clear and distinct as in the original.

The various processes of photo-engraving, such as photogravure, half-tones, photo-gelatine, autotype, photo-glyptic, photogalvanograph, photo-intaglio, etc., are different methods of reproducing absolute fac-similes, and they have elevated the art of illustration above all that man could accomplish previous to a few years ago. This is exhibited remarkably in the newspaper press, which almost daily teems with pictures taken, made and printed within an hour or two of time.

The wonderful color printing of to-day is illustrated in works on Ornithology, in which birds are shown in coloring far surpassing Audubon's great work, which cost $1,000 a copy, and which but the very wealthy could possess, even in the naturalist's own time. Now the poor can possess what fifty years ago was impossible even to the rich. (See "Photography.")

Calicoes and paper hangings are printed from metallic or wooden cylinders, over which the cloth or paper passes, or sometimes from block patterns. Modern machinery deftly performs what not long ago was slowly done by hand.

The "Art Preservative" may well stand as the symbol of the age, for no other department of industry has made greater progress during the century than the art of printing. From the wooden hand press to the rotary press, and from hand set type to the automatic type-setting machine is indeed a vast distance.

Printers need no longer fear the tyrannical power of a heartless ink trust, for printing without the aid of ink promises to be the next development. The inkless printing process is the invention of a genius named Greene. Its salient feature is the use of the electric current in place of ink, and the chief advantages claimed for it are decreased cost of production and an increase of at

least twenty-five per cent. in speed. It is also a notable economic feature that all machines now in use can be adapted at small cost to electrical inkless printing. The only changes are to leave off the rollers and all movable parts of the inking arrangement, fit a thin sheet of fine rolled zinc around the cylinder as a conductor, connect the negative and positive poles from the electric supply of the machine, and it is ready.

One feature of this process which would seem to be a great disadvantage at first glance, is the necessity of using paper that has been chemically treated, in order that it may be susceptible to the magnetic electric influence. It is stated, however, that the chemicals are added directly to the pulp and that they are so cheap as to make no appreciable increase in the cost.

Wood engraving has superseded steel and copper-plate engraving, and reached its present perfection during the last quarter of the century, but the new photographic processes have nearly supplanted it. The wonderful halftone surpasses all other forms of engraving.

If the contrast between the slow process of bookbinding of a hundred years ago and the advanced methods of the present day, is not as marked as in the earlier stages of book manufacture, it is nevertheless great. Within a few years bookbinding has had most ingenious machines constructed for cutting, book-trimming, book-folding, pressing, wire and thread sewing, rounders, backers, and inking attachments for embossing. Tools for facilitating all stages of the work are such as were unthought of fifty years ago. Smyth's book-sewing machine seems to have a spirit in its wheels, and to be endowed with life and intellect, as it automatically does the work that even to the middle of the century was a slow hand process. The rapidity and perfection with which the printed paper and crude material are picked up and brought together in the finished book by the power of the dynamo and machinery, which seems to act intelligently and of its own volition, can only be comprehended when seen.

The modern printing establishment, such as the one whence this book is issued, would entirely upset the equanimity of even so recent a past master of "the art preservative" as the philosopher who first harnessed the lightning, could he be brought to see it; and as for Guttenburg, he would regard the movements that result in the evolution of a modern book as nothing less than magic.

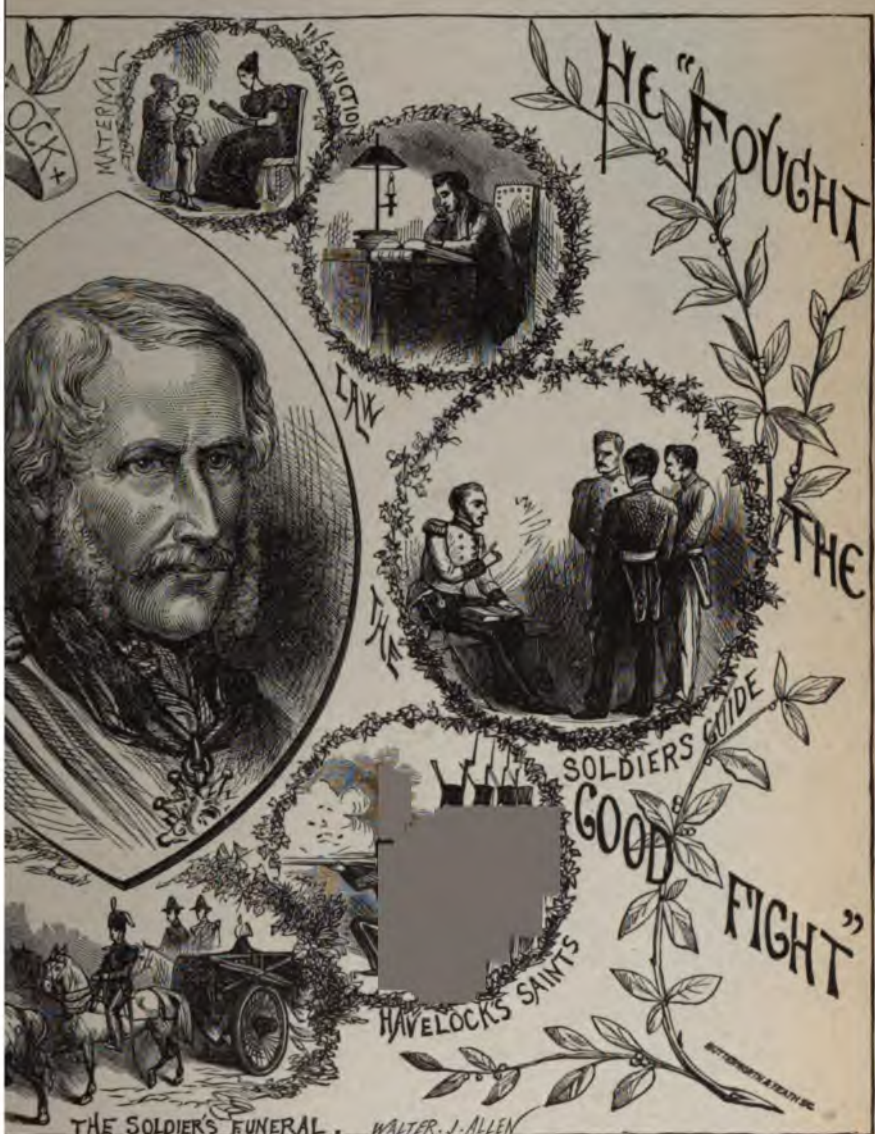
Anciently, the type of a book was all set, and the book was printed by two or three men, by strictly manual labor. Now each book is the outcome of an evolutionary process, from the raw material to the perfect result, facilitated by every appliance known to modern mechanical art. From the composing-room to the shipping department, each step in the process is a point in a prescribed circle, consequently the movement is always forward, and the greatest possible economy of time and labor is achieved.

Among the book-making appliances in a modern bindery are the stamping and inking machines; cutting machines; bundlers; casemaking machines; hand embossing presses; smashing machines, and gold brushing machines. There are also machines for cutting leather and boards; indexing machines; round cornering machines; punching machines; sawing machines; beveling machines; grinding machines; casemaking tables, a feature of which are electric glue-pots, in which the glue is kept at an even temperature by means of electricity, which can be regulated by the operator; an automatic bookbinding and covering machine, which handles a catalogue of 1,200 pages, gluing, compressing, putting on the cloth to hold the sections, covering and turning out completely-bound books at the rate of one thousand an hour, to say nothing of numerous other appliances for more expensive publications.

Electric dynamos drive all the machines, including presses, and type-setting machines. Each press is under the absolute control of the feeder and pressman. By means of a handle placed immediately at his side, the feeder can start or stop the press at will; by means of electric buttons placed at either side and on each of the three corners, the pressman can stop the press instantly. Another great advantage secured by the plan of driving presses by electricity, is the ability to vary and regulate the speed according to the character of the work to be executed. The omnipotent dynamo has almost displaced the "jour."

HENRY HAVELOCK.

[Born April 5, 1795. Died Nov. 24, 1857.]



was not only a soldier, but a Christian; and even when most earnestly busied in winning tain her Indian empire, never neglected to seek additions to the kingdom of his Lord. He in the art of ruling a battle. The indomitable Campbell and the chivalrous Outram could n himself, teach Highlander and Sikh how to conquer: it is the peculiar glory of Havelock nother discipline than that of earth he fitted his veterans to die.

CHAPTER X.

ARMS.

INVENTION OF RIFLE-BARRELS—PERCUSSION LOCKS AND POWDER—MINIE BULLETS—BEECH-LOADERRS—REVOLVERS, PISTOLS AND GUNS—RIFLED CANNON—TORPEDOES—SMOKELESS POWDER—IRON-CLADS—DYNAMITE—MONITORS.

AT the beginning of the century the muzzle-loaded, smooth-bore, flint-lock musket and pistol, and the smooth-bore, muzzle-loaded cannon, were in universal use. All the wars of Europe for the first part of the century were fought with "Brown Bess," the name familiarly given in England to the smooth-bore, flint-lock musket. It was so designated from the brown color of the barrel, produced by oxidation. The gun weighed twelve pounds and carried a leaden bullet of fourteen and a half to the pound. It continued in almost universal use until 1839, when the percussion lock began to come into general use. The whole fabric was so inartistically constructed that aim was scarcely possible. The bullets flew wildly over the field, hitting in the most unexpected places. Of all the shots which were fired in the Peninsula by the English, only one in 600 harmed a Frenchman. It was calculated that before the slaughter of an enemy could be achieved, a weight of lead equal to the weight of his body was expended. At the battle of Salamanca, Spain, there were 3,500,000 cartridges fired, and several charges made, both by the foot and cavalry, and yet there were only 8,000 men killed and wounded; that is, only one shot in 437 took effect. At Speichern the Germans disabled one Frenchman by the expenditure of 279 cartridges. A square of British infantry at Waterloo fired at short range on a body of French cavalry and only emptied two or three saddles. The French troops during the Crimean war fired some twenty-five million cartridges, of which not more than one in two thousand took effect. Most of the guns in use in the American Civil War were muzzle-loaders, though Sharpe's, Burnside's, Spencer's, and other breech-loaders were coming into use.

In 1803 Alexander Forsyth, a Scotchman, and singularly enough a clergyman, invented fulminating powder, and in 1818 Dr. Samuel Guthrie, of Sackett's Harbor, N. Y., the discoverer of chloroform, without knowledge of the European invention, invented a percussion powder, which was tested at the U. S. army post, and was pronounced impracticable by the officer in charge, on the ground that soldiers could not carry hammers to explode the percussion

powder! In 1840 Dr. Andrew Ure experimented with a detonating powder—fulminating mercury that explodes by percussion. It was first placed in little copper boxes called caps, which fitted on nipples connecting with the powder in guns, and, struck with the hammer of the gun, exploded. Later the detonating mixture was made a part of the cartridge, or shell, in breech-loaders.

Joshua Shaw, in England, in 1814, had invented percussion caps, and applied for a patent in the United States, but was refused as an alien. In 1822 he invented the percussion lock; in 1828 the percussion primer. He died in 1860. The United States Government gave him $17,000. Fulminating powder was introduced into France in 1837, but not into the United States service until 1842.

In 1826 Lieutenant Delvigne, in the French army, revived a fifteenth century method of giving a twist to the interior of the gun-barrel, and invented the chamber at the bottom of the barrel. Col. Thouvernin, of the same army, added to the efficiency of the twist by an improved method of making the ball take the twist. In 1845 Capt. Claude Etienne Minie, also French (1810-1879), invented the Minie ball, which he improved in 1849. The ball was elongated, cone-shaped, and had at the bottom a recess in which was an iron cup, which was dispensed with in 1853. The lower edges of the ball being thus made thin by the hollowing out, when the piece was discharged, the thimble was forced forward, driving outward the thinned edges of the ball, and into the grooves of the bore. The invention of the Minie ball revolutionized warfare. In 1851 the rifle barrel began to succeed the smooth-bore.

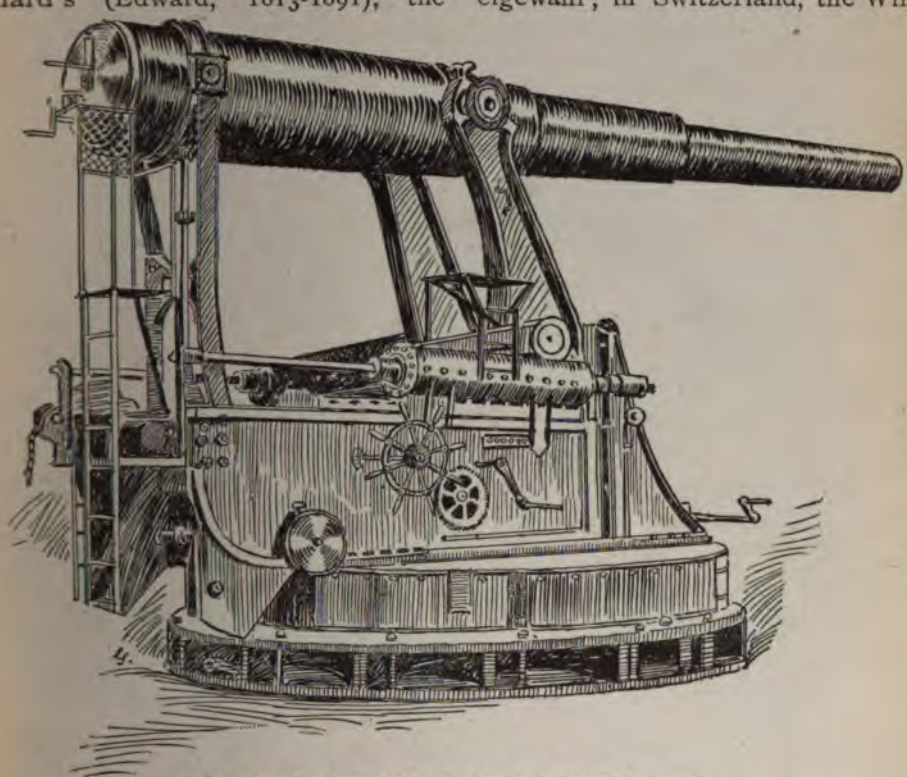
A NAVAL ENCOUNTER BETWEEN TWO WOODEN FRIGATES IN 1812.

The greatest efficiency of the gun or rifle is given by the invention

the breech-loader. It remanded the muzzle-loader to oblivion. The first one produced was the work of John N. Hall, Yarmouth, Mass., in 1811. This was used in the Mexican war and in Indian warfare to some extent, both with flint and percussion locks, and was followed by Sharpe's Rifle, Burnside's, Maynard's (Edward, 1813-1891), the Spencer, Merrill's, and subsequently came the Henry, Remington (1816), Winchester, etc. More than two thousand patents for different processes of breech-loading are recorded in the patent office—most of them comparatively valueless.

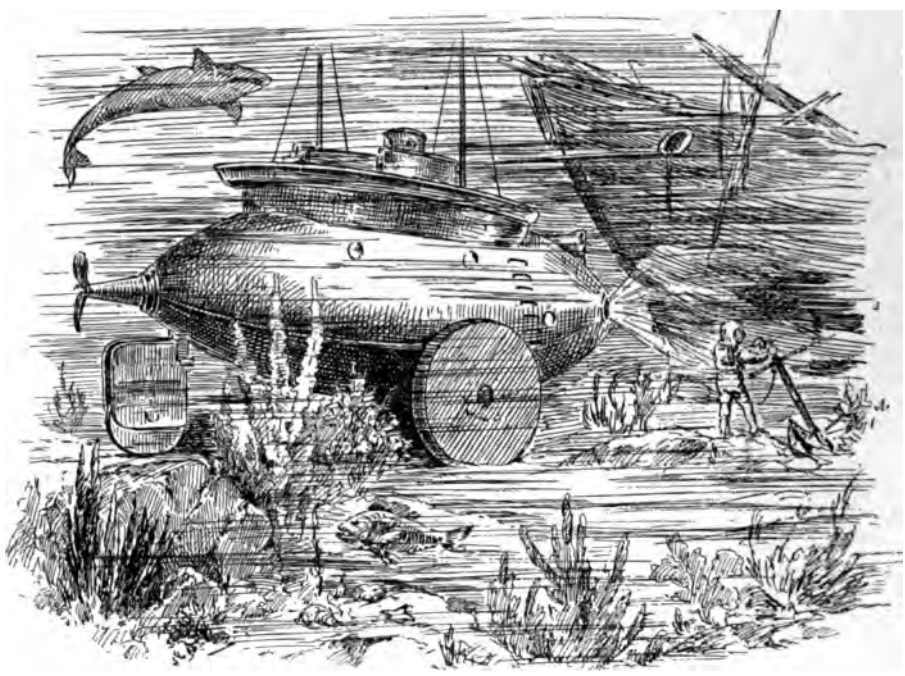
Perhaps no more potent than other rifles, yet it may be said that Sharpe's rifle was the principal factor in accomplishing the freedom from slavery of Kansas.

Of the large number of rifles now in use in the army, the principal are, in the United States, the Krag-Jorgensen; in England, the Martini-Henry, and Lee-Metford; in Germany, the Needle-gun, or Zundnadelgewahr; in Switzerland, the Winchester; in France, the Chassepot; in Turkey, the Remington and Winchester, etc. These and others are far superior in effectiveness to the heavy, slow-loading, short-ranged weapons that in 1800 were thought to be beyond improvement. Two hundred yards range was then the limit; now a thousand yards or even



A DISAPPEARING GUN ELEVATED TO THE FIRING POSITION.

more is possible. The weapons that met in conflict in the great Franco-Prussian war were the Needle-gun used by the Germans, and the Chassepot by the French. The Needle is the invention of Johann Nikolaus von Dreyse, born in Sommerda, Prussia, in November, 1787, and died in December, 1867. He was the son of a locksmith, at whose trade he worked till 1809, when he went to Paris and was there employed in a rifle factory till 1814. In 1824 he received a patent for the invention of percussion caps; in 1827 he obtained a patent on a muzzle-loading, and in 1836 on a breech-loading gun. In 1840, his breech-loader was adopted by the Prussian government. This gun is very effective. Its peculiarity is that the fulminate which fires the cartridge is placed between the powder and the bullet; when fired, a steel needle is driven through the cartridge until it strikes and explodes the fulminate. By this process all the powder is utilized. The Chassepot was invented by Antoine Alphonse Chassepot (1833), who worked in a manufactory for the construction of arms. His invention was completed in time to permit its adoption after the Prussian victories over the Austrians (1866).



A SUB-MARINE BOAT AT THE BOTTOM OF THE SEA.

There are many other rifles of more or less efficiency. The Snider rifle, named after Jacob Snider (1820-1866), the inventor, is a breech-loading rifle. The breech action consists of a simple plug con-

ın oblique needle, and be-
:d on its right side, opened
; of a thumb piece. The
d, Schmitt, Manlicher,
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apanese have recently in-
he Murata repeating rifle,
ın discharge ten shots in
onds. It is of small cali-
of great penetrating power,
nger range than the Krag-
n. Smokeless powder, the
ı of which in Japan was
eous with that in Europe, is
A new small-bore repeating
ented by Captain Dau-
; superior to any known
The bullet propelled by it
ı be capable of penetrating
from head to tail at a
of 2,000 meters, whilst be-
ıt distance the bullet has
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ot gun—repeating shotgun
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use. It may be defined as
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hand-arm ever loaded with
nd shot. The weapon is of
ore than the average army
weighs less. Its magazine has room for six twelve-calibre cartridges. Each cartridge contains three and a half drachms of powder and twelve buckshot. Between the shot and the powder are two one-eighth-inch compressed paper wads. The shell of the cartridge is of paper, backed by a rim of brass. Its outward appearance is very much like that of the ordinary shotgun shell, but its surface is thicker and much stronger. The six cartridges may be fired in half as many seconds, thus throwing seventy-two scattering bullets, any of which would inflict a serious wound at eighty yards' distance. The magazine may be reloaded easily within half a minute. It is calculated that with the shot of each cartridge, scattering as it is discharged, the gun, in the hands of a fairly accurate shot, is capable of disabling 150 men to the minute.

The telescopic rifle weighs about forty pounds and is efficient at a distance of a mile. The writer of these lines has perforated a barrel at that distance.

The various magazine rifles, which can be fired several times without reloading, are used almost exclusively in the army. Several cartridges are brought into the firing chamber, one after another, by the action of the breech mechanism. There are many kinds; the magazine in the stock, under the barrel, under the breech, above the breech, etc. It has been found that rifles with small bores shoot straighter and hit harder than larger ones. The German Mauser and the French Lebel magazines are favorites.

They are of the Remington-Keene type. The Belgians and Spaniards use the Mauser; the Austrians use the Manlicher; the British the Lee; the United States army the Krag-Jorgensen. The magazine can discharge from five to twelve rounds without changing position. The

A FLINT-LOCK.

progress from the old flint-lock, smooth-bore, muzzle-loader to the present arm is great. There were excellent breech-loading rifles in 1847, but they were not used in the Mexican war, nor to any extent in the Civil war. The modern shotguns are wonderful improvements over those in use less than a half century ago, such as the Colt, Parker, Whitmore, Baker, Winchester repeating, etc., most of them are hammerless.

The old-fashioned pistol was a clumsy and uncertain weapon from the time of its invention, in the sixteenth century, until 1830, when Lieutenant Delvigne, of the French army, produced a rifle-barrel pistol which was a great improvement on its predecessors. But in 1836, Samuel Colt, an American, invented the world-famous revolver, undoubtedly suggested by ancient weapons, which have more than one chamber, revolving at the breech. One was invented in this country as early as 1818, by Elisha Collier. The chambers were revolved by hand, but the germ of the perfect weapon was there. But Colt none the less deserves the credit of the perfected weapon, which is too common to need description here, whether known as Colt's, the original, or Smith and Wesson's, or other modifications.

Col. Samuel Colt was born in Hartford (1814-1862). Sent to school at the age of ten, he ran away and shipped on a vessel bound for the East Indies. On the voyage he made a model in wood of a revolving pistol, the same in principle as the one he gave to the world. This model is yet in existence. In 1835 he went to England and France, and patented a revolving fire-arm, and the next year patented the same in the United States. He organized a company for the manufacture of his revolver, but it became insolvent. But when the gold excitement in California broke out, there began to be a steady demand for his revolver; and then he found it impossible to supply all the weapons that were called for. The demand soon came from all parts of the world; works were constructed which cost him some $3,000,000, and from that time

MODERN REPEATING RIFLE.

on the inventor reaped a rich harvest of reward. Colt was also the inventor of a sub-marine battery.

CANNON.—Rifle bores in cannon were not in general use until 1854, when the French government, during the war with Russia, adopted rifled cannon which were first used

in the war with Italy. Soon after they were adopted by other governments. There are many kinds, the Whitworth, invented by Sir Joseph Whitworth (1805); the Armstrong, by Sir Wm. George Armstrong (1810); the Krupp, the Rodman (Thomas J., 1815-1870); the Parrott, by Thomas G. Parrott (1815-1881); the Fraser, etc. Dr. John Brahan Read (1819-1899) invented the iron shell that made the Parrott gun so efficient in the American Civil war.

The Whitworth guns are of steel, the smaller ones forged solid, the larger ones are of coils, which are forced on by hydraulic pressure. The projectiles are very long. Those intended to be used against armor are of steel, with flat heads, so that they will not glance when striking a metal plate. These projectiles have no fuse when used as shells.

The Armstrong guns are either muzzle or breech-loading. They are among the largest made, some in the Italian navy are of 100 tons.

The inventor of the Whitworth gun, Sir Joseph Whitworth (1805-1887) was born in Stockport, England. He was an inventor at an early age. In 1854 he designed a cannon with a hexagonal bore, and later applied the same principles to the construction of the breech-loading cannon which bears his name. He has been not only a mechanic, an inventor, and an engineer, but a writer, having published much on mechanical and kindred subjects.

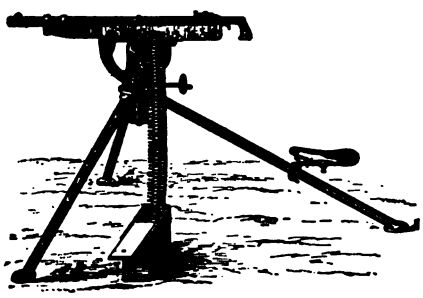
Alfred Krupp, born in Germany (1810-1887), and Frederick Alfred Krupp, his son (1855), have immortalized their names in the production of immense cannon, that would seem to be irresistible as a means of warfare. The son bears a name that is famous wherever steel and steel-making are known. The greatest purveyor of the tools of war, he is at the same time, by the very immensity of his operations, one of the greatest promoters of peace. The father conceived the idea of casting cannon in 1847. In 1856 he constructed breech-loaders of steel. In 1867 he had a gun at the Paris Exposition that carried a projectile of a thousand pounds. In 1879 he startled the world with his mammoth cannon. In 1893 his cannon, at the Chicago Exposition, elicited universal astonishment. It threw a "ball" of a ton's weight.

The ships with which Nelson achieved results so splendid had undergone little improvement in many generations. The largest ship of the line was a vessel of 2,500 tons, built of oak, and enormously strong, five or six stories in height moved by the wind, and armed with 120 guns, the largest of which threw a solid shot of sixty-eight pounds' weight. The hollow, explosive shell which has now superseded solid shot was then unused. The favorite fighting ship, however, was armed with only seventy-four guns, and manned by 500 or 600 sailors and marines. Such a vessel could discharge, in one broadside, some 2,500 pounds of iron, scarcely more than a single gun of the heaviest size can now throw.

The largest cannon in the world is on Romeo Shoals, defending New

York harbor. Its weight is 126 tons, is forty-nine feet long, and of sixteen inches calibre. Its charge of powder is a thousand pounds, and it throws a projectile weighing 2,300 pounds sixteen miles.

The Napoleon gun was invented by Louis Napoleon, A. D. 1850. His object was the construction of a



A MACHINE GUN.

gun, of medium weight and calibre, that should be capable of firing both shot and shell. It was issued in 1853 to the French divisional batteries, was used during the Crimean war, and afterward adopted by various European nations, and by the United States.

The Parrott gun—a rifled cannon, invented by Captain R. G. Parrott, of the Cold Spring Foundry, West Point (1804-1877), was much employed in this country during the Civil war, The body of the gun is of cast-iron, and is reinforced at the breech by shrinking on a ring of wrought-iron.

The Gatling gun is a machine gun, named after its inventor, R. J. Gatling, of Indianapolis, Indiana (1818), which has a cluster of barrels and a charging breech at which the cartridges are automatically loaded into the barrels and fired in succession. It was exhibited in Paris, in 1867. The Gatling is in fact a mitrailleuse, which is a weapon designed to fire a large number of cartridges in a short time. The name is given chiefly to those which are intended for use against men, firing, therefore, ordinary rifle bullets, but weapons of higher calibre, designed to discharge heavier projectiles against "material," are usually called "machine guns." In each instance, however, the weapon is a breech-loader, and the shot is carried in a metal cartridge. The earliest forms were the French mitrailleuse and the Belgian Montigny mitrailleuse, both being composed of a number of barrels fastened in a group, surrounded by a metal casing, the cartridges being contained in steel blocks, which are dropped successively into a "slot," or opening, in

A REPEATING PISTOL.

the breech, and replaced, when discharged, by a fresh plate. The rate of firing of the Montigny was about 444 shots to a minute, of the French piece 300 per minute. Those at present mostly in use are the Gatling, with ten revolving barrels, and the light Nordenfeldt and Gardner patterns, with fixed barrels. These

are fed from a drum, containing cartridges, which is placed over a slot on the upper surface of the case covering the barrels. A scattering arrangement is usually fitted to the mitrailleuse, which causes the barrels to move from side to side while the piece is being discharged. The machine-guns firing shots large enough to penetrate even thin iron plates are the Gatling, the Nordenfeldt, and the Hotchkiss, and all these have fixed barrels without any scattering machinery. The first mentioned fires 200 rounds per minute; the Nordenfeldt 100 rounds in the same time. The Nordenfeldt pattern consists of four barrels fastened side by side, horizontally in a frame. It is fed from a carrier on top of the breech of the machine, which is filled by hand as it becomes empty. In the Hotchkiss gun the barrels, five in number, revolve, and in addition to solid cast-iron and steel shot, it fires explosive shells and canisters at the rate of twenty-five per minute. The machine gun was first used by France in 1870, in the Franco-Prussian war. The latest machine gun is the Maxim. Its single barrel, after being once fired, goes on automatically, a hundred cartridges in each belt, at the rate of ten shots in a second. In 1898, at eighty years of age, Gatling completed the largest high-power gun yet made, twenty-four feet long, weighing fifteen tons, with eight-inch calibre. Before he was twenty-one he had invented a steam plow and a cotton-seed sowing machine.

The shrapnel-shell is a hollow projectile, or shell, called after its inventor, General Henrie Shrapnel. The projectile consists of a spherical iron shell filled with balls, sufficient powder being mingled with the balls to burst the shells when the fuse ignites the charge. It was hence called spherical case-shot, and was designed to attain a longer range than common case-shot or grape. The bursting charge was of just sufficient strength to open the shell without scattering the balls, which continue their flight. The improved shrapnel has its bursting charge in a cylinder in the middle of the elongated projectile used with rifled guns. Shrapnel are commonly filled with lead musket bullets; melted sulphur or bituminous matter is poured in to fill up the interstices, and a chamber sufficiently large to contain a bursting charge is formed at the base of the shell.

B. F. Hotchkiss, in 1869, produced a rapid firing, breech-loading gun, that would throw shells, which was introduced into Europe during the Franco-German war, and which at once commanded great success. This gun is now in use in American men-of-war. A six-pounder, with smokeless powder, has a range of 5,000 yards, and at 1,000 yards can hit a small target and pierce five inches of wrought iron. Twenty-five shots a minute can be fired.

Rifle shells originated with Captain Norton, in 1826. Others were invented by General John Jacobs and others.

The rapid-firing machine-guns that seem to have reached the highest possible efficiency are of the Maxim-Nordenfeldt pattern, and are

planted on places of defence, and seem impregnable to all attacks. They are really cannon, and on pivots, are very efficient on shipboard. Torpedo boats, torpedo boat destroyers, and other destructive

A SUB-MARINE TORPEDO BOAT.

agencies have been multiplied and made more efficient until it seems as though progress could not go further in the direction of destructiveness.

In the automatic guns designed by Hiram S. Maxim, the recoil of the first shot is turned to account in discharging the empty cartridge case, reloading and returning the gun to firing readiness, and by the continued pressure upon the trigger the guns continue firing until the ammunition supply becomes exhausted. The cartridges are strung on the belt containing a hundred or more—depending upon the size of the gun—and are fed into the breech of the gun right from the ammunition.

TORPEDOES.—Torpedoes, both defensive and offensive, had been invented, some of which were very effective during the American Civil war. The explosive agent employed is gun-cotton, glyoxylene, or other explosives, and the torpedo is fired by electricity, friction or contact of chemicals.

The Hudson Maxim aerial torpedo is designed for coast defense and naval warfare, and when fired it is like a bolt shot from heaven. As its name implies, this death-dealing torpedo is fired into the air instead of being shot along the surface of the water, being used like the ordinary heavy mortar. Its bore of twenty-six inches is double the size of cannon now in use. It is impossible to conceive the awfulness of its destructive force, which seems superhuman in its power. A recent writer says of it: "It will throw a ton of dynamite a distance of five miles. With all the torpedoes now in use the object aimed at must be hit or no damage is done. With the Maxim torpedo, if it strikes anywhere with-

A DYNAMITE GUN.

in 200 feet of a warship it will shiver it to atoms. He has also invented a smokeless powder to use with the torpedo. This is the most terrible invention of the age. If it proves all that is expected, and the United States government promptly takes

possession of the gun, America will be invulnerable against the combined forces of the world."

A younger brother of the inventor, Samuel Maxim, a man of no mean inventive genius himself, remarked to a newspaper reporter: "The genius of my brother runs to war; mine are to the arts of peace. Yet I am inclined to think that these marvelous inventions of Hiram and Hudson will shortly end all wars. These fearful weapons simply mean total annihilation. In my judgment the impending war with Spain will be the last fought between civilized nations. With Hudson Maxim's aerial torpedo every warship of Spain can be sent to the bottom in twenty-four hours. All the armies of the world couldn't stand before a single regiment armed with Hiram's automatic guns. These things simply mean peace. War must be abolished."

THE TORPEDO.—The torpedo is the greatest of all destructive agents. Fulton suggested it in 1807, but the British government declined to accept it, though used with considerable effect in our Civil war. It was a germ in 1860, but its present efficiency was evolved in 1864 from the brain of Captain Lupuis, an Austrian naval officer, though its unrecognized germ was in gun-cotton, invented in 1846. It has since been greatly improved. It is in appearance cigar-shaped, from fourteen to nineteen feet in length, and from fourteen to nineteen inches in diameter at its thickest point. The shell is made of steel or phosphor-bronze. Within are three compartments. In the first is a heavy charge of gun-cotton; the second is the air receiver, filled with compressed air; while in the third are the propelling engines and guiding mechanism. The Howell torpedo, invented by a United States naval officer, is not unlike the Whitehead in shape, but is driven by means of a fly-wheel contained in the shell. The first torpedo boat was built in England in 1873, by the Thornycrofts; France followed in 1875, and the United States in 1876.

Besides this type, there are locomotive, or dirigible torpedoes, which, when fired, are controlled from shore by means of a fine cable, wound up in the torpedo like a reel. It is the most dangerous of destructive engines, expressly for shore defense.

The navy departments of most nations have adopted compressed gun-cotton, both for submarine mines and for torpedo charges. It has been selected as the United States service explosive. Experiments with gun-cotton were begun by Professor Hill, at the United States torpedo station in 1872. Eleven years later the first gun-cotton torpedo outfit was issued to the United States ship Trenton, the gun-cotton being supplied in cylindrical disks three inches in diameter and two inches high.

In our service to-day we have two kinds, the Whitehead and the Howell, the latter of purely American design, and the idea of Commodore John A. Howell. In the Whitehead the motive power is compressed air, stored in the reservoir at a pressure

of 1,350 pounds to the square inch, ninety times that of the normal air pressure. The Howell torpedo is impelled by the force stored up in a heavy wheel, which is spun up just before launching to something like 10,000 revolutions a minute. The gyroscopic tendency of this revolving kept the torpedo steadily on its pathway, until recently, when the Whitehead adopted the Obry steering device, an adaptation of this same principle. The Howell torpedo was superior in this particular. The Howell torpedo is wound up by a stem motor. The steering arrangement of the Whitehead is driven by a spring wound up any time before the torpedo is placed in the tube for firing.

The electric torpedo is a torpedo operated by electricity. There are various kinds of electric torpedoes. The Sims-Edison torpedo is driven by an electric motor, and its motions are controlled from the shore by electricity. The torpedo proper is carried some distance below the surface of the water by a vessel immediately above it, from which it is suspended by two rigid bars. In the torpedo is a cable reel, on which the conducting cable is disposed. An electric motor and controlling gear are also contained within the torpedo. In its front the explosive is placed. It is driven by a screw propeller actuated by the electric motor. As it moves it pays out cable, so that it has no cable to draw after it through the water, the cable lying stationary in the water behind it. This avoids frictional resistance to its motion. The maintenance of the torpedo at a proper depth is one of the advantages of the system. The first submarine boat was probably constructed by Drebbel, a Dutchman, for James I., and Robert Fulton's in the same direction in 1801. Among recent submarine boats, the most noteworthy are the Nautilus, which made a trial trip off Tilbury, England, December 20, 1896, and the Nordenfeldt. The Nautilus is a cigar-shaped vessel, eighty feet long by eighty feet broad amidships, and the inventor, Mr. Campbell, claims that she is perfectly under control at any depth, and can be propelled at ten knots an hour when submerged or on the surface. A torpedo can also be attached to her for purposes of war.

Louis Gathman, of Chicago (1843), announces an aerial torpedo that will add to the terrors of war, and by its destructiveness will aid in hastening the era of peace. He is also inventor of a most destructive gun, which the United States government is now (1899) testing. This gun will be the largest ever cast in this or any other country. It is expected to throw 500 pounds of gun-cotton nine miles, and will totally annihilate a modern battle ship at one shot.

The eophone is a modified form of the megaphone. It consists of two large metallic ears with a dividing membrane of metal between. Ear pieces, like telephone receivers, fit on each of an observer's ears. When he hears a sound, either at night or during foggy weather, he must turn the mouth of the eophone in the direction of the sound and

continue to do so till the volume of sound in each of his ears is the same. The direction of the eophone then is the true direction of the sound or approaching object, and it is very easy to warn the man at the wheel accordingly.

DEFENSIVES.—To-day no American fighting craft is deemed complete without its belt or cofferdam of corn-pith cellulose. The pith of the stalk is cut out and ground into a coarse, mealy mass, and then under pressure moulded into blocks or briquettes. In this form it is packed into the cells made for it against the sides of the ship and about the region of the water line. The stuff weighs only a fractional part of a similar bulk of water. When the enemy's shot goes tearing through the outside plating and pierces the cellulose, if water be admitted by the rolling of the vessel, the cellulose at once swells automatically, and plugs the hole in itself as well as in the plating, thus preventing a dangerous admission of water in the ticklish region of the water line. A curious virtue of this stuff is that it does not exert a damaging pressure, as corn would do under like circumstances, but rests content simply with plugging the hole. Of course this material would be scattered by explosive shell fire, but even then, being fireproof, it will not burn.

By a chemical process all wood, except that for the decks, used on shipboard, is fire-proofed, and one of the dangerous consequences of shell fire is thus reduced to a minimum.

One of the most important inventions of the age is that by which armor can be hardened ("Harveyized") and made much more powerful against the attack of either shot or shell. The process was invented by H. A. Harvey, of New Jersey, and consists in supercarbonizing the face of the armor plate to a depth of an inch or more, as choice may determine. Offense and defense have competed. As fast as means of defense have been devised, weapons of offense have been invented to overcome them, and *vice versa.*

The armor-piercing shell is the natural answer to the Harveyized armor, and those of the Wheeler-Stirling make are the best. The projectile is manufactured by a secret process, but in principle it is on the order of Harveyized armor. The shell is gradually hardened from the base upward till the climax is reached at the point, and as a result the rest of the shell takes up the strain of impact and helps to support the superhardened point in its passage through the opposing armor. To make the chances of penetration greater, a cap, the design of Johnson, is fitted over the point. This cap is made either of soft steel or composition. Its object is to support the point squarely at the moment of entrance, and, infusing a way under the intense heat then generated, to form a lubricant for the easier passage of the projectile. It is interesting to know that this device is the direct result of accident, Mr. Johnson having discovered it in driving nails in hardwood. Usually the nail doubled up and refused to be driven in, but when driven first through an overlaying lath of pine,

the nail went in without deformation. The principle so discovered has resulted in giving us a most superior projectile. Before 1880 projectiles were of cast-iron; now of steel.

DeZeng's bullet machine (1857) manufactures 3,000 an hour; Bruff's (1873) 7,200 an hour. Metallic cartridges were first made in 1826; Colt at first used tin-foil.

EXPLOSIVES.—Gunpowder was for a long time considered the great explosive, and such it was for 500 years, but within a few years, like many other useful agents, it has been supplanted by more efficient ones. Chemistry has recently produced two forces of wonderful power, gun-cotton and nitro-glycerine.

It is one of the strange facts in chemistry that the terrible agent, gun-cotton, is produced from two perfectly harmless substances, cotton and nitric-acid. T. J. Pelouze (1807-1867) discovered, in 1838, that the addition of nitric-acid transforms cotton to gun-cotton, and in 1846 Prof. C. F. Schönbein (1799-1868), of Switzerland, described the process of manufacturing it. These modern explosives are at the base of all these substitutes for gunpowder, gun-cotton and nitro-glycerine. The so-called nitro-compounds were first discovered in 1832, when Bracount, of Nancy, found that starch, wood fibres and similar substances, would easily yield a combustible substance, which he called xyloidine, when heated with concentrated nitric acid. But no practical results followed these and other discoveries, because neither uniform effect nor stability were secured.

Nitro-glycerine was discovered in 1846 by Sobrero, professor of chemistry at Turin, but the discovery remained undeveloped for many years. In 1863 Alfred Nobel, the noted Swedish chemist, invented dynamite by mixing liquid nitro-glycerine with a highly porous infusorial earth. He also, in 1878, invented gelatin and other explosives for blasting purposes. Dynamite is used for civil, and gun-cotton for military, operations. Numerous other explosives have appeared in recent years, but most of them have disappeared after a brief and unsuccessful trial. Picric acid has been known for many years. In 1867 potassium picrate was used in America and in England as a charge for bombs. In 1887 the French government introduced picric acid as "melinite."

Austria was the first country to engage elaborately in the attempted substitution of gun-cotton for gunpowder. A factory was erected at Hirtenberg in 1853 and the explosive was introduced in some special artillery.

Between the years 1864 and 1886 the initial stages were completed which were destined to revolutionize modern warfare. In the former year E. Schultze, of Potsdam, began the manufacture of gunpowder from nitrated wood. In 1865 Sir Frederick Abel, chemist of the British war department, patented a process for purifying gun-cotton, reducing it to a fine powder by beating machines, and then pressing it. That process is now generally used. In

1886, Vieille, the celebrated chemist of the French gunpowder works, discovered a means of making smokeless gunpowder from gun-cotton dissolved in sulphuric ether mixed with picric acid.

While these experiments were progressing in England, France and Germany, Alfred Nobel formed the idea of reducing the rate of combustion in his blasting gelatine by increasing the percentage of gun-cotton, in order that it might be used as a substitute for gunpowder. This led to the patenting of a smokeless powder in 1888, called "ballistite."

Sir Frederick Abel and Professor James Dewar, members of the English committee on explosives, invented a smokeless powder consisting of a combination of the highest nitrated cellulose with nitro-glycerine by dissolving both in acetone. It was introduced into the English service as "cordite," for use with small arms and guns of all calibres. It is now composed of nitro-glycerine, fifty-eight parts; gun-cotton, thirty-seven parts; and mineral jelly, five parts. Cordite proves stable under extreme conditions varying from the arctic cold of Canada to the tropical heat of India, and resists exposure to moisture of all kinds. Its effects on the bore of guns is a serious difficulty. It erodes the gun to such an extent as to suggest its abandonment.

The United States naval smokeless powder is a nitro-cellulose powder, consisting of a mixture of insoluble and soluble nitro-cellulose, to which is added the nitrates of barium and potassium and a small percentage of calcium carbonate. The proportions for six-inch rapid-fire guns are mixed nitro-cellulose, eight parts; barium nitrate, fifteen parts; potassium nitrate, four parts, and calcium carbonate, one part. The United States war department has been experimenting with various types of smokeless gunpowder, varying from an entire composition of gun-cotton and no nitro-glycerine to a small per cent. nitro-glycerine. The "W-A" powder, proposed for service in the United States for the use of guns both in the army and navy, consists of insoluble gun-cotton and nitro-glycerine, with an admixture of metallic nitrates and an organic substance as a deterrent or regulator. Like all smokeless gunpowder, it exerts a deleterious effect upon the bore of guns.

The most destructive of agents is called in different forms by various names, such as dynamite, dualine, lithofracteur, etc. Dynamite is a mixture of seventy-five per cent. of nitro-glycerine with twenty-five per cent. of infusorial silica. The silica renders the powder less liable to explode from concussion. This is dynamite proper, but dynamite is also used as a generic name for other mixtures of nitro-glycerine; as colonial powder, which is a gunpowder with a mixture of forty per cent. of nitro-glycerine; dualine, which contains thirty to forty per cent. of nitro-glycerine mixed with sawdust saturated with nitrate of potassia; litho-fracteur, which contains thirty-five per cent. of nitro-glycerine mixed with silica, and a gunpowder made with nitrate of baryta and coal.

The new compound, lithotrite, invented by Demense, has no ill odors, and is superior to any of the other explosives.

Powder no longer describes the compound. The huge guns are discharged by chocolate colored hexagons, three by two inches each. Common powder in such a quantity as is necessary to explode the large guns would burst the piece at the first discharge.

Gun-cotton is soluble in ether, and forms collodion, one of the essentials of photography. Exposed to air the ether evaporates, leaving a thin transparent film. It is valuable to cover wounded surfaces of the body.

Smokeless powder has come to entirely supplant the old gunpowder. The only smokeless powder that has stood our government test is that which was invented by William C. Payton (1866), of California (Santa Cruz). It is made into cubes and will not explode except when compressed or confined. If touched off in the open air by a spark or match it will burn brightly, but not explode. A new gunpowder, invented by Herr Otto Hempel, a druggist of Wieda, is perfectly smokeless; it leaves no residue whatever, and the weapon only requires two-thirds of the present charge to produce the same effect, while the explosion causes but little noise. Perforated powder is a very recent invention for large guns. The French made the first really practical smokeless powder in 1883, the Lebel,—gun-cotton dissolved in a volatile solvent, dried in thin sheets, and cut into small laminæ. After that Dr. Schüpphans and Hudson Maxim entered the race. The result is a preparation of nitroglycerine, of which the United States chief of ordnance says: "The perforated cylinder of the Maxim-Schüpphans powder is the best known."

The war with Spain has demonstrated the inutility of the old black prismatic powder in modern practice. The smoke of the distant battlefield can no longer figure as a thrilling spectacle by painter and poet. Smokeless powder will be used exclusively hereafter by the great powers. We have passed almost at a jump into the smokeless stage of our military existence. Among the most prominent powders are Cordite, the British smokeless powder, invented by Sir F. A. Abel and Professor Dewar; French smokeless powder, the *Vielle poudre* of the Lebel rifle; Rifleite, which is used in the Lee-Metford gun, and in the Martini-Henry rifle; Maximite, the compound which Hudson Maxim invented; Emmensite, which proved so satisfactory under United States tests; Indurite; Cannonite; Tonite Ballistite; and last, but far from least, the terrible French Melenite. French smokeless powder is remarkable from the fact that it is "noiseless" to the same degree that it is "smokeless"—that is, it gives a very feeble report, and very little bluish smoke. It is of the nitro-cellulose class of compounds.

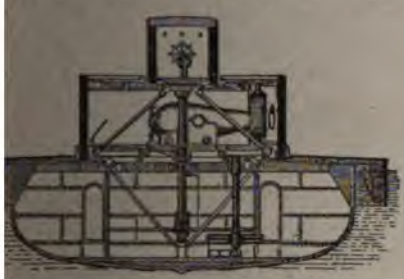
PROJECTILES, ETC.—The shrapnel shell is an iron cube containing a number of bullets. The bursting charge of powder is behind them, and they travel fan-shaped, carrying havoc along a wide path.

A MODERN CRUISER.

"Modern methods of warfare enabled Dewey to execute what would have been deemed magic by Paul Jones or Farragut."

FARRAGUT AT MOBILE.

any minor inventions have added the efficiency of arms. The rometer is the invention of Lieu- nt Commander W. H. Beehler, of navy. In brief, the solarometer stitutes an artificial horizon for natural one, and this is done by ries of swinging rings actuated the bowl of a compass, which



SECTION OF A MONITOR.

ps the solarometer always hori- tal, no matter how the ship may

he range-finder is for the quick accurate determination of the ance of an approaching enemy, is fashioned upon a simple prin- e of applied geometry or survey- The stadimeter is the range- er, for one person, where either known length or height of an ect stands in the stead of that e established between the two tions of the range-finder just cribed.

he Colomes leak-stopper is com- ed of corn-pith cellulose.

RMORED VESSELS. — John csson, a Swede (1803-1889), the enious builder of the "Monitor," the inventor of the gas, or flame ine, an apparatus for making salt brine, a file-cutting machine, a ice for creating artificial draught ocomotives; the solar-heat engine, the screw propeller, etc. The invention of the screw is also claimed for Joseph Ressel, Austria. Commodore John Stevens (1749-1838), of New Jersey, is said to have worked a screw propeller on the Hudson in 1812. The Monitor is also claimed to have been suggested by Captain Cooper Coles, in England (1819-1870) in 1869, but a letter is extant from Ericsson to Napoleon III., in 1854, which proves the priority of his invention. Ericsson demonstrated the uselessness of wooden war vessels by the invention of his torpedo boat, the Destroyer. It is so swift that it overtakes the iron-clad; it offers small surface to attack; it is heavily armored, can be practically submerged, and when within fighting distance fires under water by compressed air a projectile containing sufficient dynamite to raise a big warship out of the water. When the projectile strikes a ship the terrible explosion takes place.

JOHN ERICSSON.

In no branch of warfare have the means of offense and defense been, in a few years, the subjects of so much change, both in type and effectiveness, as in naval construction and armament. For centuries after

the invention of fire-arms the progress in the direction of invulnerable warships was very slow, and it was not until the naval operations of the American Civil war had given to the civilized nations of earth a great object lesson that the development of ships as fighting machines was accelerated. Prior to that time the strength of naval vessels was considered to lie entirely in the number of men and guns that a ship carried. The building by the Confederate government of the ironclad ram, "Virginia," directed the attention to the value of armor-clad ships, and especially such ships when armed with a beak or ram, as a means of offense. The construction by Captain Ericsson of the "Monitor," and the successful fight of that vessel against the "Virginia," convinced naval architects that the wooden warships had suddenly become obsolete. From this point the development of strength in warships is marvelous. Ericsson's Monitor was ignored by our government until the desperate panic caused by the Merrimac compelled us to test her.

The system of plating ships with iron was first used in the United States in 1812; in France in 1821, and in England in 1827, but, though the results were satisfactory, no advance was made until 1857, when the French again took the lead with the "Gloire," built by Dupuy de Lome, but were quickly followed by the first English armored vessels of the "Warrior" class, to which were added, to strengthen the ironclad fleet, altered wooden line-of-battle ships, such as the "Royal Alfred," which were cut down and plated. All the early vessels were constructed of wood, but the later specimens have been built of iron framing, and few of the modern ships are alike. The first crucial test to which ironclad vessels were subjected, however, was reserved for the American navy to apply. An old wooden steam vessel, the "Merrimac," was razed by the Confederates and covered with iron (railroad rails, etc.), the sides sloping up to an apex like the acute angle formed by an old-time house roof. In addition to the iron plating thus applied, the ship was armed with a spur or point for the purpose of ramming the enemy's ships. Operations were begun against the Federal war vessels in Hampton Roads, Virginia, in the early part of the year 1862, and as a result several of them were either sunk, battered, or run aground in their endeavors to escape from the formidable foe. After the "Cumberland" and "Congress" had been irretrievably injured and the "Minnesota" run aground, the "Monitor," the first turreted ironclad ever used in active warfare, the production of Captain John Ericsson, appeared in the roadstead, and then began the first naval duel between ironclad vessels. Neither the "Virginia," as the "Merrimac" had been rechristened, nor the "Monitor" was much injured in the fight, but owing to the less draught of the "Monitor," the Southern vessel was rendered practically useless and obsolete (March 8, 1862), and in a few days thereafter was run down the James river to Craney Island and sunk by

Lieutenant Charles H. Hasker, an English naval officer, who had immigrated to this country and joined the Confederate service. The "Virginia" was commanded by Captain Franklin Buchanan (1815-1874), while Lieutenant John Lorimer Worden (1818) commanded the "Monitor." During the engagement between the two vessels Lieutenant Worden was seriously injured by fragments of a projectile, which struck a grating through which he was looking, the flakes of iron flying into his face and blinding him. The success of the "Monitor" gave rise to numerous vessels of the same type, the salient features of which were a low free board and a revolving turret, and practically revolutionized naval warfare. After honorable service the "Monitor" foundered off the North Carolina coast, along which she was being towed to one of the Southern ports.

Jevons, of Liverpool, built an iron boat in 1815; Aaron Manby, an iron steam vessel in 1821; in 1830 an iron vessel, eighty-four feet long, was built in Manchester, and soon after the Lairds built the Alburka, for Lander's exploration of the Niger. These were all in England. Meanwhile the French were experimenting, and, as more effective arms were coming into use, and it was seen that wooden vessels could not withstand them, attention was more and more devoted to the construction of iron ships. The Minie rifles, the Armstrong and Whitmore cannon, and other tremendous engines of war necessitated stronger than wooden ships, and at length, not only war vessels, but all other ships were built of iron.

The increase of force in guns has rendered useless for defense the most formidable forts of stone, and their walls must be iron-plated to resist attack. Earth-works and iron-clad stone walls are everywhere replacing the granite bastions that fifty years ago were impregnable.

Floating batteries were employed in the Crimean war, and at the same time the wooden ships of war began to be iron-plated. France began and England followed. At that time sixty-eight pound projectiles were the heaviest in use. But the armor increased in thickness as projectiles increased in force. And invention has increased the efficiency of the man-of-war until it is now a marvel of resisting and destructive strength.

In 1898 a new Greek Phoenician fire was successfully tested in Germany. It ignites on contact with the air or water, and cannot be quenched by either water or earth. It burns with a brilliant flame, exceeding big search lights, and it can be sunk under water or under ground, and when brought to the surface instantly bursts into flame at any desired point.

The warships of the nations are now everywhere clad in plate that renders them very nearly invincible. The wooden men-of-war, by which the pride of the British navy was humbled in our Revolutionary war, and whose undefended sides were riven by the shot of the enemy, are superseded by vessels clad in armor so massive that almost no weight of shot can pierce it. We

have artillery which will throw, with unerring precision, a mass of iron weighing 2,000 pounds to a distance of five miles. By the help of electricity we can send against hostile ships an explosive force whose discharge will scatter them to the waves, and utterly destroy the hundreds of brave men who form their crews.

A great modern improvement is the Disappearing gun, invented by Captain Moncrieff. In front of the gun is an immense shield of sand and concrete, presenting no projection of angles, which would reveal its location. Behind this the gun lies hid. It is loaded, given the proper elevation and direction, rises, discharges its projectile, and the recoil returns it to its hidden position.

There are ships of war able to throw every minute one 1,100 pound shell, or three of 250 pounds each, or ten of 100 pounds, or fifteen of sixty pounds each, or twenty of four pounds. The 1,100 pound projectile fired from one of the four thirteen-inch guns, strikes with an energy of 25,000 foot tons—force enough to lift a big ship bodily two and one-half feet. If the commander wishes, he can so connect his batteries with wires as to fire all the guns simultaneously, striking the adversary with such a tremendous storm of projectiles that no ship could stand up against it. There are shells that will travel a mile in a second, and will kill a man without touching him.

On land the modern war engines are equally effective. There is light artillery of three and two-tenths inches calibre. These are the most efficient cannon for field purposes constructed up to date. They can deliver projectiles with a muzzle velocity of a quarter of a mile per second, and their effective range is four miles. The projectiles employed are usually shrapnels, each one in bursting being resolved into about 300 fragments. The flying fragments form a cone 500 yards long, and when one of these missiles explodes in front of an advancing enemy, the damage is widely distributed. But, no matter where the enemy is, whether behind hills or breastworks, the artilleryman has only to get his elevation, and he can drop his shrapnel where he likes. This sort of shell is exploded by a time-fuse.

To illustrate the destructiveness of modern weapons on land let it be supposed that a command is well posted and concealed with a six-gun battery of these small breech-loading cannon, a couple of Gatlings, and a regiment of 700 infantry, armed with Krag-Jorgensen rifles. A hostile force of twice the strength approaches to within a distance of 3,000 yards. The range being carefully calculated, allowing for the expansion of the cones of fire from the artillery, the six cannon will cover a line of 1,440 yards. At the word, firing begins, and in one minute thirty-six shrapnel are hurled at the advancing foe. They burst 200 yards in front of the enemy, scattering 10,800 messengers of death among them. In the same minute the two Gatlings deliver 2,000 shots, and the 7,000 rifles discharge 14,000

projectiles. In sixty seconds the space occupied by 1,500 men has been swept by a tremendous storm of 26,800 missiles, and two-thirds of the on-coming soldiers are laid low. One more minute, with another such discharge, and few survivors are left to tell the tale of disaster. A Spanish officer in Cuba said that the fire of an American regiment seemed like the discharge of a hose. A new record for rapid-fire guns was made in July, 1899, on the proving grounds of the Driggs-Seabury Gun Company, at Derby, Connecticut. The gun, which was a six-pounder, made a record of sixty shots per minute, which was twenty-five better than the record of the most modern rapid-fire gun.

The growth of anarchism has been accompanied by the invention of destructive agencies of assassination and murder, called bombs. These terrific agents of destruction have been used with murderous effect in the larger European cites; St. Petersburg, Madrid, and Paris; also in America, in Chicago. The anarchists have regularly established factories for the production of these missiles, in which the elements are combined with great nicety and scientific precision. The usual method of construction is to fill a hollow sphere with some high explosive, together with pieces of scrap-iron, nails, bullets, or anything that will wound. The explosives used are generally nitro-glycerine, fulminate of mercury, etc. The most deadly of all agents, however, is a bomb made with chlorate of potash and picric acid. These substances are separated by a wadding of raw cotton (soaked in sulphuric acid), which acts as a time fuse, for when the picric acid soaks through the cotton and reaches the potash a terrific explosion ensues. The usual way of packing these bombs is in a tin cylinder with two glass compartments inside, one (the bottom one) containing the liquid acid and the top one the potash. To cause the explosion reverse the can and let the liquid soak through.

Thus within the century modern science and invention have entirely overturned and revolutionized all the forms, modes, and means of marine warfare and coast defense; iron and steel have taken the place of wood in naval architecture, and great gun-making has been carried forward to a degree of perfection undreamed of during the earlier half of the century. A Krupp gun, of 100 tons weight, that will send a 1,000 pound shell or shot for seven to nine miles on its errand of destruction, is a marvel indeed.

The novel and startling uses to which electricity has been put in naval and other warfare are likely to play a decisive part in future struggles. Already mines and great guns are fired, turrets are turned, ammunition is hoisted and search-lights, as well as incandescent lights, are supplied by the electric current.

Cannon of enormous size are now made of solid steel—more than 100 tons weight; they carry projectiles weighing several tons, with a thousand pounds of powder.

The quick-firing guns are very destructive. They fire ten or twelve

rounds a minute, and send a greater weight of metal in a given time than does a far heavier gun.

"Floating petards" were used by the English in the seventeenth century. Bushnell, of Connecticut, in 1776, invented a "marine turtle," with clock-work to explode a torpedo, which blew up the British ship "Eagle," in New York harbor. In 1805, Fulton invented a similar infernal machine, which was successfully experimented with in England. In 1807 he repeated his experiment at Washington, but his head was so full of his steamboat that the torpedo was dropped, though he thought the torpedo of more consequence than the steamboat, and so wrote to Joel Barlow. He revived the matter during the war of 1812, but the American government did not encourage it. Torpedoes were lavishly used during the Civil war, both on land and in water. Thirty-nine Federal ships were blown up by Confederate torpedoes, and the famous "Monitor" was built to employ them. They are stationary as mines—exploded by concussion, or by wire from shore; projected from ship or shore, or self moving on the surface or under water. They are among the most destructive agencies of war.

"The most wonderful machine ever invented, from the point of view of the highest mechanical ingenuity and perfection of construction, is the Whitehead torpedo. In the hands of skillful and resolute men, it is the most terrible engine of warfare the world has ever seen. A ship which receives a blow from it is doomed as surely as if she were already sunk."

Maxim's twenty-four inch aerial torpedo carries half a ton of picric acid incased in one ton of steel. Total weight, 3,000 pounds. Range, eight and one-half miles. It will penetrate the deck armor of battleships, or the belt armor of protected cruisers, and exploding inside, utterly destroy them.

John Louis Lay (1831-1899) invented the Lay torpedo, with which Lieutenant William B. Cushing (1842-1874) destroyed the Confederate gunboat "Albemarle," in 1864.

The new United States army and navy copper-jacketed cartridge will cut through fifty-four pine boards, seven-eighths of an inch thick, or kill at a mile.

Captain Zalinski's pneumatic gun, by means of compressed air, throws 500 pounds of nitro-gelatine.

The present tendency is to reduce the calibre and weight and number of shells in magazine guns and cannon, and increase projectile force and rapidity of firing. The latest bullets resemble lead pencils in shape.

In 1898, Willard S. Isham, of Vermont, invented a shell, carrying 150 pounds of explosive gelatine, which, detonating in the water within twenty-five feet of a battleship, would blow her sides right in. Fired from one of the big seacoast guns, an Isham shell, with a detonator fuse, would sail twelve miles out to sea and explode in the midst of a hostile fleet with the same destructive force as if it were detonated at the gun's mouth.

The wonderful variety and extent of the expedients in offensive and

defensive warfare cannot here be described. Submarine torpedoes, electrical agencies, dynamite, nitro-glycerine, balloons charged with deadly compounds, are already in the field, and are rendering warfare so expensive in money and life as to show that it must at no distant day no longer prevail.

The latest submarine boat is the invention of Simon Lake. The hull is mounted on three wheels, which enables it to move in any direction on the bottom of the sea. By means of compressed air divers can leave the interior of the "Argonaut" and explore any part of the sea, and examine wrecks, repair or destroy submarine wires, and affix torpedoes to hostile ships. The craft can float or sink at the will of its navigator. A gasoline engine operates the screw, the driving wheels, the dynamo, the air compressors, etc. Interesting descriptions of the boat and a voyage in her may be found in McClure's Magazine for January, 1899.

Few departments contain greater contrasts between 1800 and 1900 than weapons and methods of offensive and defensive warfare. The smooth-bore, flint-lock, muzzle-loading gun and pistol, and the clumsy wooden sailship were rude, indeed, compared with the breech-loaded rifle-barrel musket and pistol, with percussion lock, and Minie or Mauser bullet, mammoth disappearing cannon, fired almost automatically from steel men-of-war, monstrous in size and swift of motion, pouring out tons of destructive missiles at a broadside when hundred weights were once deemed the utmost possible, with dynamite, torpedoes, submarine and aerial, discharged by electricity, and a hundred efficient means of destruction undreamed of a hundred years ago—these enable the Deweys and Schleys of to-day to execute what would have been deemed magic by Nelson, or Paul Jones, or even Farragut. And though these engines of destruction would seem to increase the horrors of war, they really mitigate them. This is well illustrated in the brevity of modern, compared with ancient, wars. The Prussian and Austrian war of 1866 lasted but seven weeks; the Franco-Prussian war of 1871, six months; the Russian and Turkish of 1877, nine months; the Japanese and Chinese, 1894, eight months; the war between Turkey and Greece, 1897, four and a half weeks; that between the United States and Spain, in 1898, less than four months.

The compound, triple and quadruple expansion engine, with coil boilers, in place of the single engine, has made possible that terrible engine of destruction, the modern warship. The same amount of coal has trebled the steaming radius. The machinery of the simple engine weighed 670 pounds per horse-power. The most recent ship machinery weighs but sixty-nine pounds per horse-power.

Steam and electricity seem to have been designed to promoting the ends of peace, and yet nothing has more contributed to the success of war. And yet up to 1840 the navies of the world were sail vessels.

The application of electricity to naval uses has enormously increased efficiency. The turret gear, ammunition hoists, cranes, winches, etc., are all moved by electricity, and this force is rapidly increasing its varied uses. The electric searchlight has become of the greatest service on shipboard and on shore to transform night to day.

Not only has warfare become more and more humane, but international law forbids treachery, explosive bullets, cruelty to prisoners, storming of cities, and many other cruelties, that once were allowed. Those who die from wounds or in hospitals are but a fraction of the injured and sick compared to fifty years ago, in consequence of the humane expedients, and improved medical, surgical, and other means that accompany all armies.

It is a remarkable fact in human progress that it keeps pace with improved war facilities. The Dark ages possessed rude weapons. Barbaric methods of warfare were in harmony with the intellectual darkness of the times. Efficient weapons seem necessary to human progress. Gunpowder preceded the printing press, and the warship and rapid-firing gun not only reduce the number of killed and wounded in battle, but promote peace among the nations by their very destructiveness. Civilization and human improvement are promoted by the increased efficiency of weapons of warfare. The Krag-Jorgensen, Mauser, rapid-firing gun, and warship, stimulate the progress of mankind.

It seems a contradiction to say that the more murderous methods of warfare, that have been produced in recent years, have reduced the relative number of killed and wounded in battle, and are sure prophecies of the reign of peace; but it appears to be certain that the time is rapidly approaching when science will have produced such terrible engines of war, at such enormous expense, that nations will resort to the arbitrament of war only at the last extremity, and that wars will grow briefer and more infrequent and will at last wholly cease. The greatest mortality in battle prevailed before the invention of gunpowder, when soldiers met man to man, face to face, and with sword, spear, scythe or sickle, contended for the mastery. Wars will decrease in the ratio of improved methods of destruction, so that, while the lover of human progress must say with the poet,—

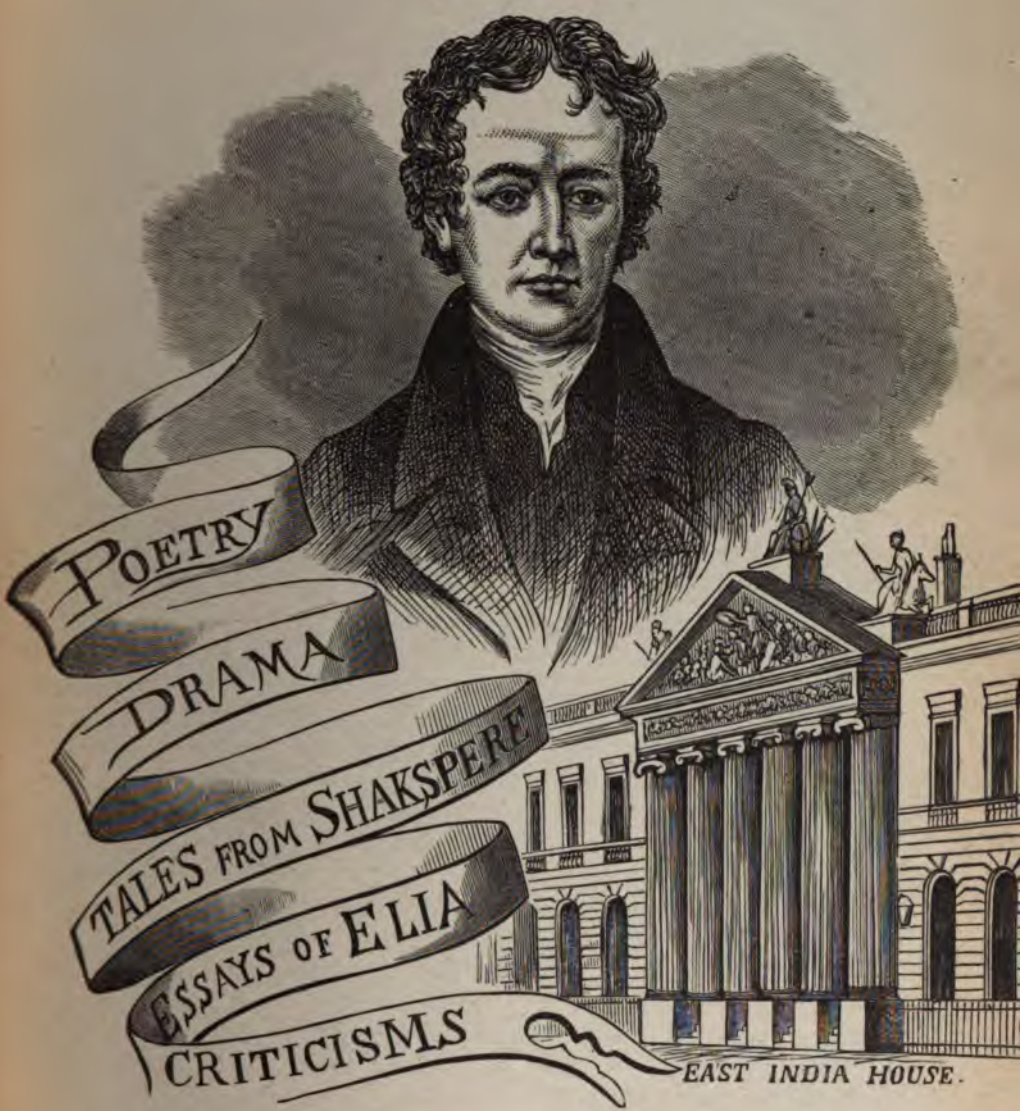
"Were half the power that fills the world with terror,
Were half the wealth bestowed on camps and courts,
Given to redeem the human mind from error,
There were no need of arsenals and forts,"

He must also concede that the worst instruments of destruction will hasten the time when

"The war drum throbs no longer, and the battle flags are furled—
In the Parliament of men, the federation of the world."

CHARLES LAMB.

[Born 1775. Died 1834.]



He lies buried with his beloved sister, who survived him many years, in Edmonton churchyard. A story of greater self-sacrifice and nobler unselfishness could not be told. He had some faults; none knew them better than himself, and they are candidly acknowledged in more than one of his essays. His place in literature no one can possibly dispute. He ranks with Addison, Steele, Temple, Shenstone, and Macaulay, and is equal to the best of them.

CHAPTER XI.

CANALS.

THE GREAT ARTIFICIAL WATER-WAYS—THE MIDDLESEX—THE ERIE—THE AMSTERDAM—THE WELLAND—THE SUEZ—THE CHICAGO DRAINAGE—THE NICARAGUA, ETC.

THESE useful waterways have been more or less used from remote antiquity, but more than ever they belong to the present century. Those of the current hundred years excel all others as feats of engineering skill. The great Chinese Canal is the progenitor of modern canals. It was made 300 B. C., is 650 miles long, and crosses several rivers and connects large cities by water transportation.

The Middlesex Canal, between Lowell and Boston, Mass., was the first of any importance in this country, or in the century. It was opened in 1804. It is twenty-six miles long. In 1832 the compiler of this volume occupied a long summer day in being dragged by horses along this waterway. Now less than an hour by rail will accomplish the journey.

The Caledonian Canal in Scotland was projected in 1803 and opened in 1822. It is sixty miles long, across Scotland; opened for traffic in 1822; completed in 1847.

The famous Erie Canal connects the waters of Lake Erie with those of the Hudson River. It was conceived in the fertile brain of De Witt Clinton (1769-1828), though it had been proposed and dropped by Governeur Morris (1752-1816) in 1777. It opened the highway of commercial progress between the region of the Great Lakes and the great ocean, and gave New York pre-eminence as the business and financial American metropolis, which it has thus far maintained. The Erie Canal was refused national aid, and New York completed it. The first earth was turned by De Witt Clinton, July 4, 1817, and the work was finished October, 1825. The tolls paid the cost of construction in ten years. Before it was built freight was $100 a ton, and it took twenty days from New York to Buffalo. Freight at once dropped to $14 and ultimately to $3, and a week sufficed to convey it. In 1819 a steamer was put on the canal. At once Ohio, Michigan, Illinois, and Indiana began to be populated.

The Amsterdam, or Great North Holland Canal, was completed in 1825. It is 125 feet wide at the water surface, 88 feet and 7 inches wide at the bottom, and has a depth of 20 feet; it extends from Amsterdam to the Helder, fifty-one miles.

The Languedoc, or Canal du Midi, connecting the Atlantic with the Mediterranean, was completed in 1861; its length is 148 miles; it has more than 100 locks and about 50 aqueducts, and its highest point is

600 feet above the sea; it is navigable for vessels of upward of 600 tons.

The great Manchester Ship Canal, extending from Eastham (the head of navigation of the Mersey River, near Liverpool) to Manchester, England, was formally opened January 1, 1894. With the use of the electric light, steamers are able to navigate by night as well as by day, and the whole length of the canal is traversed in about ten hours. The length of the Manchester Canal is about forty miles.

The Welland Canal in Canada has accomplished large results in promoting commerce, and is prominent among the many similar achievements of the century.

The North Sea Canal, connecting the North Sea with the Baltic, is 61 miles long, 200 feet wide at the surface and 85 feet at the bottom. It floats the largest ships in the German navy. It was designed by Otto Baensch, and cost more than $40,000,000. The working plant consisted of 8,600 men, 55 steam engines, 90 locomotives, 2,473 cars, and 133 lighters.

The Panama canal route is about forty miles in length. It is about one-third completed (1899), and has cost $250,000,000. It is thought that the remainder can be done for $150,000,000. The Panama Canal requires 200,000,000 cubic yards of excavation; the Suez, 80,000,000; the Drainage, 40,000,000.

The chief project in this department of human effort up to the time of its construction was the Suez Canal, connecting the Red Sea and the Mediterranean. Pere Enfantin, in 1833, interested Ferdinand DeLesseps (1805-1894) and Mehemet Ali, the Pasha of Egypt (1769-1849), in the enterprise, and in 1846 it was started and John Hawkshaw (1811), an English engineer, aided in its success. It took fourteen years to build it. It is 100 miles long; twenty-five yards wide, average; and twenty-six feet deep, minimum. It shortens the distance from Liverpool to Bombay one-half. It is an immense factor in the world's commerce. It was opened in great state by the Empress Eugenie, in November, 1869. It cost $92,000,000.

Already the Nicaragua canal is in the air, and it is safe to say that California, the Sandwich Islands, Japan and China, as well as Europe and the Atlantic coast will, in the twentieth century, derive from the marriage of the Atlantic and Pacific untold advantages. It will add immeasurably to the naval power and political influence of the United States. The Chicago Drainage canal is the greatest achievement in this line ever undertaken by man. The city of Chicago is building it at an expense of $32,000,000. The Suez Canal is but a puddle in the sand compared to it. The canal was begun September 3, 1892, and will be completed about the end of 1900. It is forty and one-half miles long, 160 feet wide at the bottom, and 162 feet at the water line in the rock section. It will not only carry off the immense sewage of Chicago, but it will be a ship canal connecting the lakes and the gulf by means of the Illinois and Mississippi rivers.

MARIA EDGEWORTH.

[Born 1767. Died 1849.]

Miss Edgeworth's novels are distinguished for the genial humor which runs through them, for sobri-
y of judgment, for the vivacious and perfectly natural dialogues which are introduced, and above
l for the admirably drawn character studies with which all her works abound. Some critics have
und fault with her novels as being too didactic to please as fiction should please. But Miss Edge-
orth was professedly a moral writer, and never if possible let slip an opportunity of enforcing on the
ader's attention some important moral precept.

CHAPTER XII.

INDIA RUBBER AND GUTTA-PERCHA.

THE WONDERFUL STORY OF RUBBER—CHARLES GOODYEAR—THE THOUSAND AND ONE USES OF INDIA RUBBER.

INDIA rubber, or caoutchouc (gum elastic), is an elastic, gummy substance, consisting of the inspissated juice of various more or less milky species of plants. The greater part of the caoutchouc of commerce is the product of trees, *siphonia elastica*, from French Guiana, *s. braziliensis, lutea* and *brevifolia* from Brazil; *ficus elastica*, sometimes called by way of pre-eminence the India rubber tree, *castilloa elastica*, and *urceola elastica*. Rubber exists to a certain extent in most milky plants. It was first exported to Europe early in the eighteenth century, and was discovered by Charles Marie de la Condamine (1701-1774). Doctor Priestley pointed out that it might be used to rub out pencil marks, crumbs of bread having been previously employed for that purpose. At that time a cube of half an inch sold for about $1.50. In 1791 Samuel Piat obtained a patent for making waterproof fabrics by caoutchouc dissolved in spirits of turpentine. In the early part of the century India rubber was mainly used in small cubes for erasing pencil marks. About that time five hundred pairs of rubber shoes were imported into Boston, the first to be used in the United States. These were of the crudest sort, probably molded by dipping into the liquid gum rude lasts, made of earth, which were broken when the gum was hardened. The wearer seemed to have club feet, so shapeless were these shoes.

The story of India rubber is one of the most interesting in the volume recording human inventions. Its first use beyond the uses mentioned above was by an Englishman named John Clark, who in 1813 patented an air-bed, the inner case of which was of rubber, inflated. The same year, Jacob F. Hummel, of Philadelphia, invented a waterproof varnish of rubber to spread on garments. Various schemes were suggested, most of them too expensive, to utilize rubber for garments, which were not fully successful until Mackintosh, a Scotchman, in 1823, hit upon the method that immortalized himself, by fabricating "waterproofs" that still bear his name, "mackintoshes." The sap exported hardens *en route* and the question was how to dissolve it so as to manufacture mackintoshes inexpensively. His son explains:

"Upon the introduction of coal-gas into Britain for the purpose of lighting apartments and the streets of towns and cities, the manufac-

turers of the article found that the tar and other liquid products resulting from the process accumulated upon their hands, in the shape of a most disagreeable and inconvenient nuisance. Mr. Mackintosh, chiefly with a view to the production of ammonia to be employed in the manufacture of cudbear (a dye, corrupted from the name of the chemist Cuthbert), entered, in 1819, into a contract with the proprietors of the Glasgow gas-works, to receive for a term of years the tar and ammoniacal waters produced at their works. After the separation of the tar into pitch to suit the purposes of the consumers, the essential oil of naphtha is produced; and the thought occurred to him of its being possible to render this also useful, from its power as a solvent of caoutchouc or India rubber. By exposure to the volatile oil named naphtha, obtained from the coal tar, he converted the substance into a waterproof varnish."

CHARLES GOODYEAR.

He amassed a fortune, but he was destined to be supplanted by a genius who, in pursuit of the object of his search, underwent more privations than all the rewards that resulted to him could compensate for, Charles Goodyear, of Connecticut (1800-1860). He observed in January, 1838-9, says the American Encyclopedia, "that a piece of India rubber, mixed with ingredients, among which was sulphur, when accidentally brought in contact with a red-hot stove, was not melted, but that in certain portions it is charred, and in other portions it remained elastic, though deprived of adhesiveness. The material was vulcanized; *i.e.*, it had undergone the change produced by a high degree of artificial heat. Thus was presented the germs of the two forms of vulcanized India rubber, now commonly known as the soft and the hard compounds."

He kept his invention a secret, and neglected for a long time to take out patents. It seems that an Englishman, Thomas Hancock, analyzed some of Goodyear's rubber, discovered his secret, and patented the process, in 1844, a few weeks before Goodyear's papers were filed. Hancock had utilized it in making wrists to gloves, garters, soles of boots, etc.

Poor Goodyear began his business life as a hardware merchant, but his business ended disastrously, and he spent ten years in a debtor's prison. While here he occupied his mind in seeking some process by which rubber goods could be kept from becoming stiff in cold weather. He fairly began his investigations in 1834. He experienced incredible hardships as he pursued his experiments.

One after another of his discoveries was successful, only the material

A TRIUMPH OF ENGINEERING.

"Chicago drainage canal is 40½ miles long, 162 feet wide and 35 feet deep."

CHICAGO DRAINAGE CANAL.

"Will not only carry off the immense sewage of Chicago, but it will be a ship canal connecting the lakes and the gulf."

nted, or rotted, and was un-
ble. Even when success was
ed, he reaped no financial ben-
or he died before he was able
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warded a medal at the Crystal
, London, in 1851; at Paris, in
e received a medal, and the
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namely, in 1844, he succeeded
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of business, and he never was
derive much benefit from his
discoveries. He died in 1860,
ointed and insolvent. The
l States Commissioner of Pat-
aid in 1858: "No inventor,
ly, has ever been so harassed,
mpled upon, so plundered by
ordid and licentious class of
ers, known in the parlance of
rld as 'pirates.' The spolia-
their incessant guerilla war-
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there are nearly a thousand
o which rubber is put, as the
of Goodyear's inventive gen-
Says James Parton (1822), in
orth American Review, July,

"Some of our readers have been out on the picket-line during the war. They know what it is to stand motionless in a wet and miry rifle-pit, in the chilly rain of a southern winter's night. Protected by India rubber boots, blanket, and cap, the picket-man performs in comparative comfort a duty, which, without that protection, would make him a cowering and shivering wretch, and plant in his bones a latent rheumatism to be the torment of his old age. Goodyear's India rubber enables him to come in from his pit as dry as when he went into it, and he comes in to lie down with an India rubber blanket between him and the damp earth. If he is wounded, it is an India rubber stretcher, or an ambulance provided with India rubber springs, that gives him least pain on his way to the hospital, where, if his wound is serious, a water-bed of India rubber gives ease to his mangled frame, and enables him to endure the wearing tedium of an unchanged posture. Bandages and supporters of India rubber avail him much when first he begins to hobble about his ward. A piece of India rubber at the end of his crutch lessens the jar and the noise of his motions, and a cushion of India rubber is comfortable to his arm-pit. The springs which close the hospital door, the bands which exclude the drafts from doors and windows, his pocket-comb and cup and thimble are of the same material. From jars hermetically closed with India rubber he receives the fresh fruit that is so exquisitely delicious to a fevered mouth. The instrument case of his

surgeon, and the store-room of his matron contain many articles whose utility is increased by the use of it, and some that could be made of nothing else. In a small rubber case the physician carries with him and preserves his lunar caustic, which would corrode any metallic surface. His shirts and sheets pass through an India rubber clothes-wringer, which save the strength of the washer-woman, and the fiber of the fabric. When the government presents him with an artificial leg, a thick heel and elastic sole of India rubber give him comfort every time he puts it to the ground. In the field this material is not less strikingly useful. During the late war armies have marched through ten days of rain, and slept through as many nights, and come out dry into the returning sunshine with their artillery untarnished and their ammunition not injured, because men and munitions were all under India rubber."

There seems to be literally no end to the uses to which this most accommodating article may be adapted by the inventive genius of man, not one of which was suspected until this century was well under way.

Ebonite is "hard rubber." It is vulcanite with a larger proportion of sulphur, and the addition of shellac, gutta-percha, sulphates of zinc, and antimony or copper. Combs, engine hose, belts, buttons, canes, brushes and innumerable articles of use and beauty are manufactured from the various preparations of rubber.

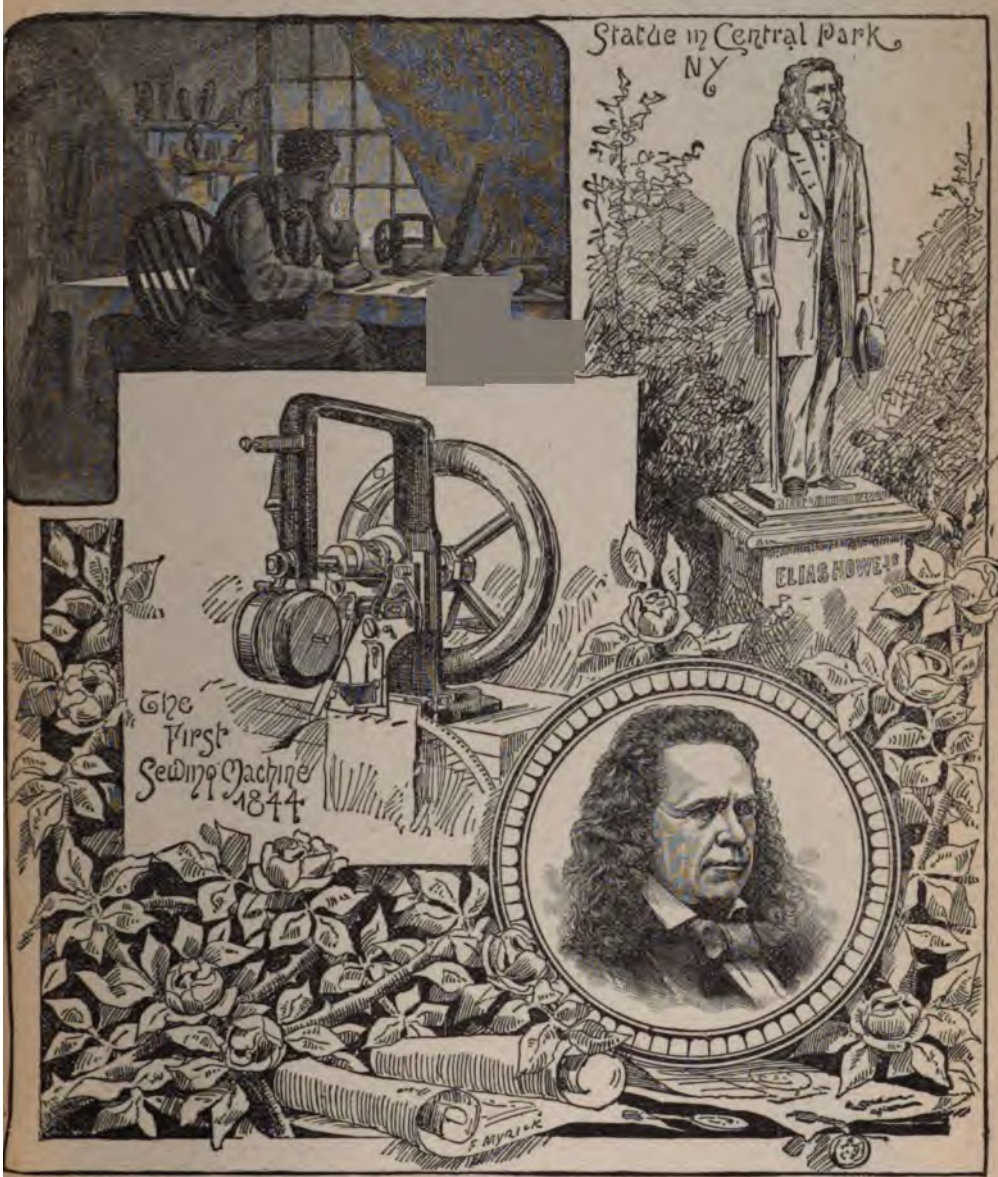
Rev. H. Martyn Hart, of Denver, perfected an invention which will revolutionize the rubber trade. Napier Ford discovered a method of oxidizing oils, and when he died, in London, in 1896, he handed his invention to Charles Griest, who made some improvements in it, and then turned it over to Dean Hart. The dean, who is an expert chemist, worked on it for months, and finally made it valuable commercially. The business end of the process was turned over to Dr. John Gower, who went to London and organized a company for its manufacture. The new substance is called perchoid. It costs only about five or six cents a pound.

The utilization of gutta-percha, the insipissated juice of *Isonandra Gutta*, a tree that grows in southeastern Asia, is one of the most useful of modern discoveries. It was first brought to notice by Dr. Montgomery, of Singapore. In 1822 it was sent to Europe, but did not have any commercial value until 1844. It is not elastic like rubber, but it is utilized in many ways. It retains stamps and may be moulded into any shape, which hardens, and so fulfils many useful and ornamental purposes. There are thousands of articles of use and beauty made of rubber and gutta-percha which were not only unattainable, but unthought of when the present century came in.

Gutta-percha seems to have been discovered on purpose to perfect one thing,—the telegraph. It was first employed in electrical experiments, in 1848, by Faraday. It is a perfect insulator, and preserver of the wires, which are not only coated with it, but enclosed in a tubing of it. There is nothing known that could take its place in insulating cables.

ELIAS HOWE.

[Born 1819. Died 1867].



It is characteristic of nearly all really great inventions that they have occupied the minds of several different persons at the same period of time, but it is seldom indeed that the rights of a claimant have been so universally conceded as they have in the case of Elias Howe and his wonderful little mechanism. Nor is there a particle of evidence going to prove that Howe pursued any other plans than such as were the coinage of his own fertile and inventive brain.

CHAPTER XIII.

THE SEWING MACHINE.

ITS INVENTORS—THIMONIER—WALTER HUNT—ELIAS HOWE—WILSON—GIBB—WHEELER—SINGER—TRIPP—SMYTH—THE THRILLING STORY OF THE ALMOST HUMAN MACHINE.

THE idea of the sewing machine seems to have been conceived as early as 1790, for the records of the English patent office show a patent for a sewing machine made by Thomas Saint, dated July 17, 1790, which has excited (according to the American Cyclopedia) considerable surprise and interest in consequence of its possessing many of the elements of successful modern sewing machines. It made the chain stitch. Later, in 1804, John Duncan applied for an embroidery machine patent, involving some of the principles of the modern sewing machine. In it hooked needles were attached in a straight line to a horizontal bar, the forward motion of which carried all the hooked ends through the cloth, when, on being supplied with a thread by a feeding needle, the reverse motion carried back loops which passed through and secured those of the previous stitch.

THE FIRST SEWING MACHINE COMPLETED.

In evolving the perfect machine all sorts of problems were solved. The running stitch was developed by Heilman in 1829; and the center-eyed, two-pointed needle had been devised by Weisenthal in 1755. J. J. Greenough in 1842, and Bean in 1843, improved the machine somewhat. In 1830 a French inventor, Thimonier, produced a machine that successfully sewed clothing for the French army. He greatly improved his invention, and in 1846 he was using a large number of his machines, when the French workmen destroyed them all, and the inventor himself just saved his life by flight. He abandoned his labors and died without benefit from his ingenuity. In 1841 Newton and Archbold, England, made the first needle with the eye in the point.

Walter Hunt, of New York, invented a machine, in 1834, with the double lock-stitch which seems to have been a successful one, inasmuch as Howe was sued for infringing it, and the inventor himself, who had neglected to secure a patent, attempted to secure one in 1854, which was refused because not obtained

earlier. It is the opinion of mechanics that Hunt might have preceded Howe in the vast revenues that the latter enjoyed had he pushed his enterprise in time. Poor Hunt never reaped any financial returns for his ingenuity.

Machines more or less imperfect, but all embodying the sewing machine idea, were patented in this country by Lye in 1836; by Greenough in 1842, by G. H. Corliss (1817-1888) in 1843, and by the English inventor Garland; and the double loop stitch by Fisher and Gibbons, in 1844. With the exception of Hunt, these all seem to have been but partially successful.

The inventor whose machine achieved perfect success, and brought millions to its author, was Elias Howe, Jr. (1819-1867). He was a farmer's boy, though he worked in early youth in making cards for carding cotton, and in machine shops. While he was employed in a shop repairing nautical instruments he conceived the idea of the sewing machine. The Atlantic Monthly, May, 1867, tells the story: "In the year 1839, two men in Boston—one a mechanic and the other a capitalist—were striving to produce a knitting machine, which proved to be a task beyond their strength. When the inventor was at his wit's end, his capitalist brought the machine to the shop of Ari Davis, to see if that eccentric genius could suggest the solution of the difficulty and make the machine work. The shop, resolving itself into a committee of the whole, gathered about the knitting machine and its proprietor, and were listening to an explanation of its principle, when Davis, in his wild, extravagant way, broke in with these words:

"'What are you bothering yourselves with a knitting machine for? Why don't you make a sewing machine?'

"'I wish I could,' said the capitalist, 'but it can't be done.'

"'Oh, yes it can!' said Davis; 'I can make a sewing machine myself.'

"'Well,' said the other, 'you do it, Davis, and I'll insure you an independent fortune.'

"There the conversation dropped, and was never resumed. The boastful remark of the master of the shop was considered one of his sallies of affected extravagance, as it really was; and the response of the capitalist to it was uttered without a thought of producing an effect. Nor did it produce any effect upon the person to whom it was addressed. Davis never attempted to construct a sewing machine.

"Among the workmen who stood by and listened to this conversation was a young man from the country, a new hand named Elias Howe, then twenty years old. The person whom we have named capitalist, a well-dressed and fine-looking man, somewhat consequential in his manners, was an imposing figure in the eyes of this youth new to city ways; and he was much impressed with the emphatic assurance that a fortune was in store for the man who should invent a sewing machine. He was the more struck with it,

because he had already amused himself with inventing some slight improvements, and recently he had caught from Davis the habit of meditating new devices. The spirit of invention, as all mechanics know, is exceedingly contagious. One man in a shop who invents something that proves successful will give the mania to half his companions, and the very apprentices will be tinkering over a device after their day's work is done. . . . Before that day, the idea of sewing by the aid of a machine had never occurred to him."

Howe himself describes his experiences: "I commenced the invention of my sewing machine as early as 1841, when I was twenty-two years of age. Being then dependent on my daily labor for the support of myself and my family, I could not devote my attention to the subject during the working hours of the day, but I thought on it when I could day and night.

GERMAN PEASANT USING A SEWING MACHINE.

"It grew on, till in 1844 I felt impelled to yield my whole time to it. During this period I worked on my invention mentally as much as I could, having only had the aid of needles and such other small devices as I could carry in my pockets, and use at irregular intervals of daily labor at my trade. I was poor, but, with promises of aid from a friend, I thereafter devoted myself exclusively to the construction and practical completion of my machine. I worked alone in an upper room in my friend's house, and finished my first machine by the middle of May, 1845.

"This was a period of intense and persistent application of all the powers I possessed to the practical embodiment of my mechanical ideas into a successful sewing machine. I soon tested the practical success of my first machine by sewing with it all the principal seams in two suits of clothes, one for myself and one for my friend.

"Our clothes wore as well as any made by hand-sewing. I have my first machine still; and it will now sew as good a seam as any sewing machine known to me. My first machine was described in the specification of my patent; and I then made a second machine to be deposited in the patent office as a model. I then conveyed one-half of my invention and patent to my friend for five hundred dollars; in fact, though a much larger sum (ten thousand dollars) was named in the deed, at

his suggestion. My patent was issued on the 10th of September, 1846. I made a third machine, which I tried to get into use on terms satisfactory to myself and friend. For this purpose I endeavored to attract notice to it by working with it in tailors' shops, and exhibited it to all who desired to become acquainted with it.

"After my patent was obtained, my friend declined to aid me further. I then owed him about $2,000; and I was also in debt to my father, to whom I conveyed the remaining half of my patent for $2,000. Having parted with my whole title, and having no means for manufacturing machines, I was much embarrassed and did not know what to do. My brother, Amasa B. Howe, suggested that my invention might succeed in England, where, if patented, it would be wholly under my control; and on my behalf, with means borrowed of my father, my brother took my third machine to England to do the best he could with it. He succeeded in selling my machine and invention for 200 pounds, cash, and a verbal agreement that the purchaser should patent my invention in Great Britain in his own name; and if it should prove successful, to pay me three pounds royalty on each machine he made or sold under the patent. He also agreed to employ me in adapting my machine to his own kind of work at three pounds a week wages. The purchaser obtained a patent for my machine in England, and I went to London to enter his employment. I then made several machines with various modifications and improvements, to suit his particular sort of work, and they were put to immediate use; but afterward we ceased to be friendly, and I was discharged from his employment.

"In the meantime, my wife and three children had joined me in London. I had also, at the suggestion of another person, endorsed a hundred pound note, on which I was afterward sued and arrested; but I was finally released on taking the poor debtor's oath. By small loans from fellow mechanics, and by pawning a few articles, I managed to live with my family in London until, from friendly representations from some American acquaintances, the captain of an American packet was induced to take my wife and children home to the United States upon credit. I was then alone and extremely poor in a foreign land. My invention was patented and in successful use in England, but without any profit to me, and wholly out of my control. In the spring of 1849 I was indebted to a Scottish mechanic for a steerage passage, and I returned to the United States poorer, if possible, than when I left. On my return I found my wife and my children very destitute; all their personal effects, save what they had on, being still detained to secure payment for their passage home.

"My wife was sick, and died within ten days after my arrival. During my absence in England, a considerable number of sewing-machines had been made, and put in operation in different parts of the United States; some of these by the procurement of the friend to whom I

had sold half of my American patent, or under rights derived from him, but most of them infringements of my patent.

"Having obtained from my father, in the summer of 1849, an agreement to re-convey to me his half of my patent, I tried to induce the friend who held the other half to join me in prosecuting our rights against infringers, but he declined to do so. After failing to make any satisfactory settlement with the infringers, who well knew my poverty and embarrassments, I filed a bill in equity against one of such persons, and made my friend a party defendant also, in order to bring him into court as co-owner of my machine. After this he joined me in a suit at law against another infringer. In this case the validity of my patent was fully established by a verdict and judgment at law. After several transfers of the half share sold my friend, I purchased it back about five years ago, and I am now sole owner of the American patent."

The indescribable privations and sufferings experienced by Howe, and his magnificent triumphs, when his revenues reached into millions, have never been surpassed in the life of any inventor.

During the Civil war between the North and the South, Howe's zealous patriotism led him to enlist as a private soldier in the Seventeenth Connecticut volunteers. To this example of what a citizen in any station owes to his country, whenever that country may demand the sacrifice from him, Howe also added the voluntary use of his means for the payment of the regiment. He served until failing health compelled his retirement from the ranks; but this simple incident has conferred upon the eminent inventor and millionaire an honor greater in its way than any he may have derived from the ribbon of the Legion of Honor, or from those other decorations that marked the appreciation of foreign governments for his achievements in the domain of mechanical science. Howe's first machines cost $300 apiece. Better ones can be now made for $10.

The sewing-machine idea seems to have been in the air about the middle of the century, for in 1849, Allen C. Wilson, of Pittsfield, Massachusetts, a cabinet-maker, who had never seen a machine, invented the rotary hook and originated the famous Wheeler and Wilson. A. B. Wilson invented the four-motion feed. Similarly in 1849, William O. Grover, a Boston tailor, invented the Grover and Baker stitch, and added the now famous machine to the competitors for the market. In 1854, James E. Gibbs, of Virginia, on seeing in a scientific paper an illustration of a machine, in which the machinery for producing the stitch, was not visible, evolved the stitch by a revolving hook, and the Wilcox and Gibbs entered into the field. David M. Smyth invented the rotary looper. Mr. Smyth also developed the first machine for sewing soles on shoes; also the first book-binding sewing machine. Smyth's book-sewing machine seems the most perfect of the sewing machines.

Isaac M. Singer appeared in Bos-

ton, in 1850, exhibiting a carving machine, when he saw several sewing machines on exhibition, and with the eye of inventive genius saw where they could be improved. He suggested three important improvements, and at once constructed a model, in 1851. He was poor, and the shopkeeper loaned him $50, and he tackled his task. He says:

"I worked day and night, sleeping but three or four hours out of twenty-four, and eating generally but once a day, as I knew I must get a machine made for $40, or not get it at all. The machine was completed the night of the eleventh day from the day it was commenced. About nine o'clock that evening we got the parts of the machine together and commenced trying it. The first attempt to sew was unsuccessful, and the workmen, who were tired out with almost unremitting work, left one by one, intimating that it was a failure. I continued trying the machine, with Zieber, who furnished the $40, to hold the lamp for me, but in a nervous condition to which I had been reduced by incessant work and anxiety, was unsuccessful in getting the machine to sew tight stitches. About midnight I started with Zieber to the hotel where I boarded. Upon the way we sat down on a pile of boards, and Zieber asked me if I had not noticed that the loose loops of thread on the upper side of the cloth came from the needle? It then flashed upon me that I had forgotten to adjust the tension upon the needle thread. Zieber and I went back to the shop. I adjusted the tension, tried the machine, and sewed five stitches perfectly, when the thread broke. The perfection of those stitches satisfied me that the machine was a success, and I stopped work, went to the hotel and had a sound sleep. By three o'clock the next day I had the machine finished, and started with it to New York, where I employed Mr. Charles M. Keller to get out a patent for it."

Says Parton: "Great and manifold were the difficulties which arose in his path, but one by one he overcame them all. He advertised, he traveled, he sent out agents, he procured the insertion of articles in newspapers, he exhibited the machines at fairs in town and country. Several times he was on the point of failure, but in the nick of time something always happened to save him, and year after year he advanced toward an assured success. We well remember his early efforts, when he only had the back part of a small store in Broadway, and a little shop over a railroad depot; and we remember also the general incredulity with regard to the value of the machine with which his name was identified. Even after hearing him explain it at great length, we were very far from expecting to see him one day riding to the Central Park in a French diligence, drawn by five horses, paid for by the sewing machine. Still less did we anticipate that, within twelve years, the Singer Company would be selling a thousand sewing machines a week, at a profit of a thousand dollars a day. He was the true pioneer of the mere business of selling machines, and

made it easier for all his subsequent competitors."

Seth D. Tripp, Lynn, Massachusetts (1825-1897), invented processes of boot and shoe making by machinery. In 1862 Tanner invented a machine for sewing the backs of books. There are now some thirty different machines, of which David M. Smyth invented, in 1879, the most successful. It costs $1,500. Wire or thread is used. Smyth has forty patents on this machine, which is manufactured by the Smyth Manufacturing Company, Hartford, Connecticut. There are some thirty different sewing machines in use, and nearly 4,000 patents have been entered. The principal are the Howe, the Singer, the Wheeler and Wilson, the Florence, the Weed, the Wilcox and Gibb, the Domestic, the New Home, the St. John, the White, the Smyth, etc. They are used in making harnesses, shoes, carriage trimming—in fact, wherever the hand-needle was formerly employed. There are many collateral inventions, such as the hemmer, ruffler, edger, button-hole worker, and the tuckmarker, by Harry Goodrich, and various other attachments that make the sewing machine one of the most valuable adjuncts of civilization. They are of several classes: (1) Those in which the needle is passed completely through the work, as in hand-sewing. (2) Those making the chain stitch, which is wrought by the crochet-hook or by an eye-pointed needle and auxilliary hook. (3) Those making a fair stitch on one side, the upper thread being interwoven by another thread below. (4) Those making the lock-stitch, the same on both sides. There are sewing machines for all kinds of work, boots and shoes, book-binding, hats, corsets, carpet-making, leather work, gloves, embroidery, pocket-books, rubber goods, buttonholes, tents, banners, flags, etc. The button-hole sewing machine was invented by Miller, 1854, and Humphrey, 1862.

The large number of sewing machine attachments that need not here be named, have all been evolved from ingenious brains, since Howe produced his mechanism.

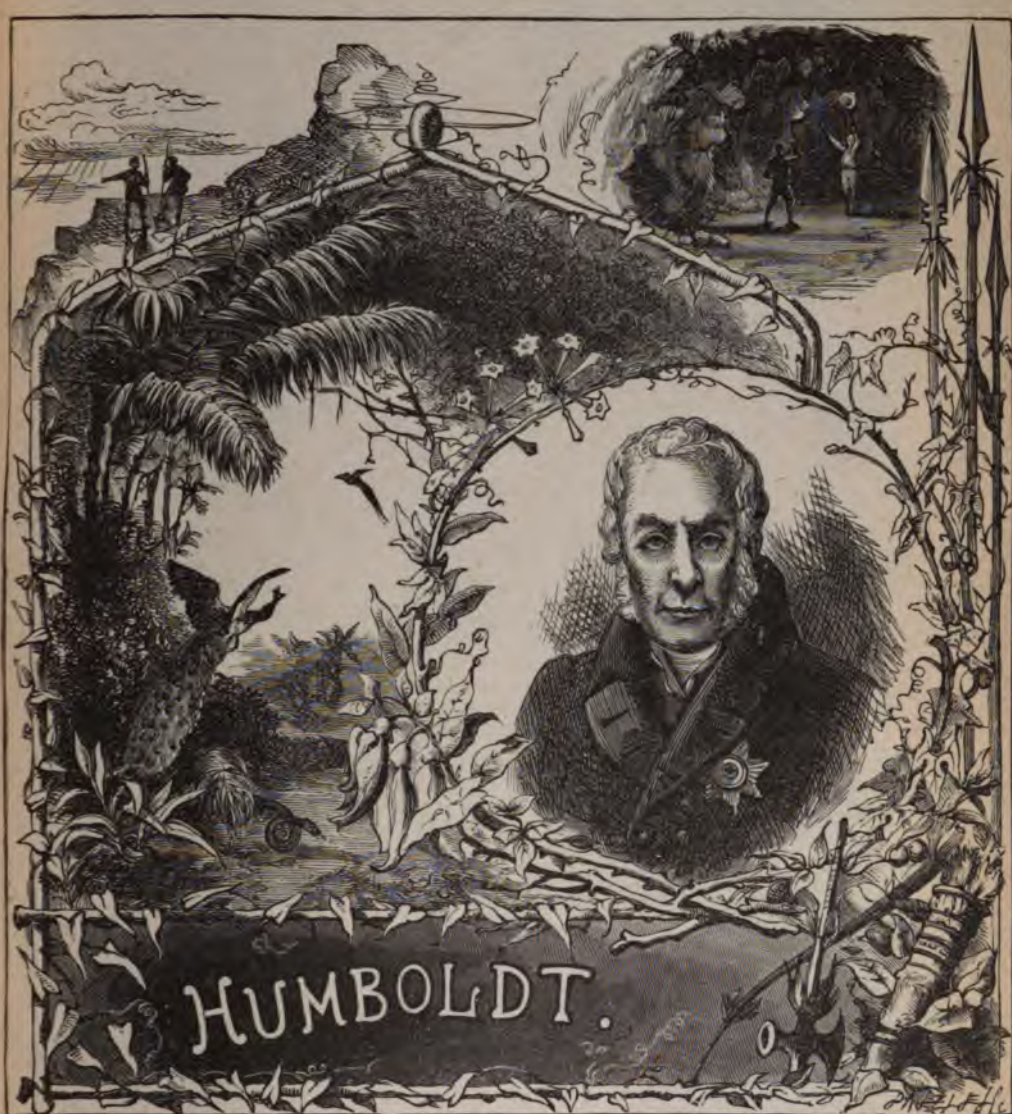
The sewing machine does everything that the hand-needle can do, and more, and its value to the world is incalculable. Of the nearly thirty kinds there are hundreds of thousands in use, and their saving of labor amounts to millions annually. At the same time, by opening so many avenues of labor, they cause the employment of many fold more people than would otherwise be employed, and in addition the wages of sewing women have been increased. The sewing machine, like most inventions, has been a benefactor to mankind. Says the Mechanical Dictionary: "If required to name the three subjects of invention on which the most extraordinary versatility of invention has been expended, the answer should be, without hesitation, the sewing machine, the reaping machine, and breech-loading fire-arms. Each of these has thousands of patents, and while each of them is the growth of the last forty years, it is only during the last twenty-five years that they have filled any notable place in the world."

It was at first prophesied that the sewing machine would ruin the business of sewing women, but ten times as many now support themselves by the machine as would have done so by the hand-needle. The demand for work has been increased by the sewing machine. Sojourner Truth (1775-1883) well observed: "God has been so good to women, giving them the sewing machine, that they might have more time to glorify Him, and they have used it to make tag-rags to put on themselves."

It is estimated that there are 700,000 sewing machines made every year in this country alone.

BARON HUMBOLDT.

[Born 1769. Died 1859.]



A great traveler, like a great poet, must be born, not made. Yet it is not given to every one who has the inborn taste for travel to gratify his wish. A rare few, by the exercise of an indomitable perseverance, may indeed create a way; but it is not the way which, had they been free to choose, they would deliberately have selected. Happy, then, is he to whom Nature has given the will and for whom Fortune has provided the way. Such a man was Frederick Henry Alexander von Humboldt.

CHAPTER XIV.

THE TYPEWRITER.

THE GOOSE QUILL PEN OF 1800—THE STEEL PEN—THE GOLD PEN—THE FOUNTAIN PEN—THE TYPEWRITER—ALL BUT THE QUILL PEN THE INVENTIONS OF THE NINETEENTH CENTURY.

VERY few of the present generation appreciate the value of one of the almost indispensable conveniences of life, the steel or

THE STENOGRAPHER OF A CENTURY AGO.

gold pen. When the writer of these lines went to school the only pens in use were made of goose-quills. One of our scholastic arts was pen-making; and a penknife was a necessary implement of the schoolroom, and a constant appurtenance of a writer or clerk. No one who has not used both can conceive of the greater convenience of the steel pen. The softness of quill pens, and their difficulty and inconvenience, suggested more durable substitutes. Steel pens had been made experimentally and as curiosities, but the first modern pen as an article of use was made in 1803 by Wise, in London. He was followed by Perry, and in 1822 by Gillott. Pens were then first stamped out. The cost in 1822 was $35 a gross. In 1830 they had fallen to $2; in 1832 to $1.50; in 1861 to 12 cents. The steel pen was not used in this country until 1832. Now more steel is made into pens in this country every year than in all the guns, swords, and needles in the world.

The gold pen followed, with nib of osmium and iridium; the cheap-

THE STENOGRAPHER OF TO-DAY.

est and every way the best pen in use. The fountain pen was first invented by Scheffers in 1835. Parker

about the same time invented another, the MacKinnon stylograph. They have been succeeded by Wirts's, Waterman's, and many others. They are wonderful conveniences, especially when one is *en route*. They were undreamed of a hundred years ago.

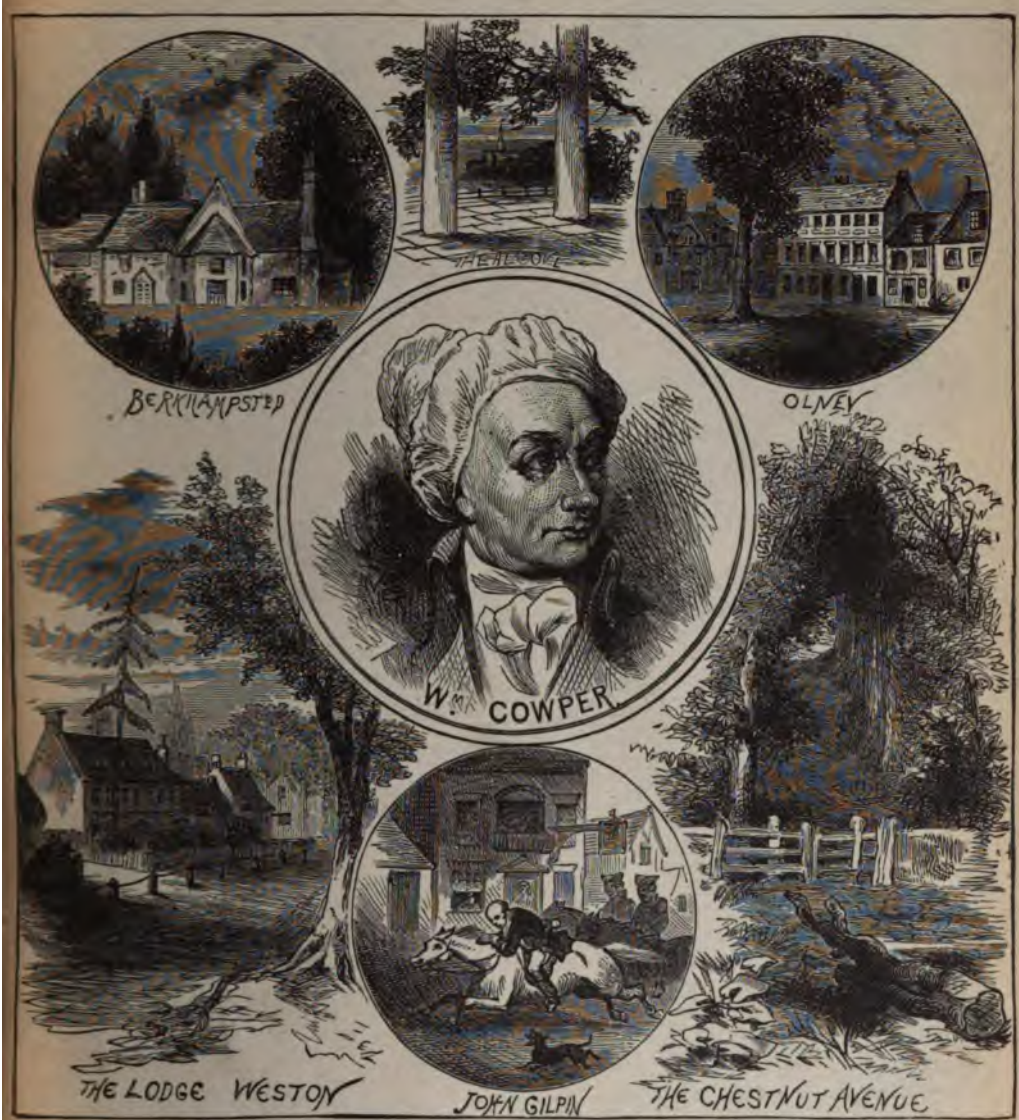
After the goose-quill had been for a long time superseded by the steel pen, the gold pen, and the fountain pen, the typewriter appeared. The first typewriter was a machine with raised letters, invented by Henry Mill, of England, in 1714, for the use of the blind; but beyond marking the era of mechanical writing machines, it was of no value, and for nearly one hundred and forty years no step forward was made. As long ago as 1843 patents were taken out for writing machines, but they were all more or less impracticable. In 1851 S. W. Francis secured a patent, but the successful inventor of the wonderful amanuensis was C. Latham Sholes (1819-90). He first invented a machine for automatically paging books, and in 1868, in Milwaukee, he perfected the typewriter. It was first manufactured in Ilion, N. Y., in 1873. During his lifetime Sholes patented some thirty working models. In 1890, thirty factories produced $3,630,126 on a capital of $1,421,783. An expert has typewritten more than two hundred words in a minute.

Typewriters are of various kinds, but all are furnished with (1) a movement for bringing the type to a common printing point; (2) a contrivance for inking the type; (3) a movement for impressing the type on the paper; and (4) an arrangement for spacing words and lines. The typewriters ordinarily in use are not as large as a sewing machine, and are worked by means of keys, each communicating with a lever terminating in a sort of transverse bar or crutch head, which carries a type at each extremity. By means of two keys at opposite ends of the board the paper carrier is moved backward or forward, so that in one position it receives a blow from one end of the transverse bar, and in the other position from the second end. In an older and simpler form of typewriter each key governs a lever furnished with a single character, instead of one at each end. The types are inked by means of a ribbon, placed directly over the point where all the types strike the paper; it is made to move a slight distance every time a key is struck, so that every type touches it in a fresh place. The average speed of a good operator is seventy words a minute.

This useful article now gives employment to hundreds of thousands of operators, and is an essential appurtenance of the business office, the professional man, the author, and of thousands who find its work the perfection of manuscript. Nearly all the improvements, and certainly the credit for the general introduction of the typewriter, belong to America. To-day there is one firm in this country which manufactures more than fifty styles of machines, in all languages, and even in business ciphers. In these last the keyboard is lettered as usual, but the characters as printed are in cipher.

WILLIAM COWPER.

[Born 1731. Died 1800.]



Any estimate of Cowper which confines itself to literary criticism is necessarily inadequate. An earnest and indefatigable lover of his species, he gave his moral support to every institution which had for its object the elevation of the masses, the suppression of wrong, or the amelioration of pain. When he sang to "charity," he celebrated that which was the chief component of his own nature. His works are a reflex of all that is best in man's nature. His philosophy is that of a Christian philanthropist.

CHAPTER XV.

THE BICYCLE.

THE DANDY-HORSE—THE VELOCIPEDE—THE TRICYCLE—THE PNEUMATIC TIRE—THE HYDROCYCLE—THE RAILROAD BICYCLE, ETC.

THE bicycle, velocipede, or "dandy-horse," was first used in France toward the end of the last century. The Johnson bicycle, patented in England in 1818,

THE DANDY-HORSE.

was a mere support to the rider, whose feet touched the ground. Self-propulsion was next attempted by pulling levers with the hands or treading with the feet. In this kind of velocipede there were three wheels, but it never became very popular on account of the labor. Gavin Dalzell (1811-1863) was the inventor of the modern wheel, in 1846. He did not patent his invention. It was the first genuine bicycle ever made. It was a clumsy affair, but the principle was involved. It was patented in 1866 by Pierre Lallement, a Frenchman, residing in the United States. In the year 1868 the bicycle was introduced into this country. This velocipede consisted of two wheels—as the name implies—of equal size. The rider sat on a saddle connected with the backbone, and propelled himself by pressing his feet on pedals at the ends of cranks which turned the wheel. It was a great improvement on the dandy-horse, but, owing to the heavy weight of the machine, faulty bearings, and the vibration—which was so great that this form of the velocipede acquired the name of "bone-shaker"—the bicycle never became really popular until the introduction of the India-rubber tire. The attention of manufacturers was then attracted toward further improvement.

AN UP-TO-DATE TANDEM.

Starley, of Coventry, England, invented a light wheel, consisting of a steel rim, grooved for the receipt of the pneumatic tire, with stretched spokes of thin steel wire. This

"tension" wheel was so light and graceful, yet strong, that it at once superseded the old one, and virtually created the modern velocipede. The size of the hind wheel was reduced and the front one enlarged, and the bicycle was finally perfected by the invention of almost frictionless "ball bearings," in which the spindles roll between free polished steel balls. The popularity and usefulness of the bicycle led manufacturers to improve the old three-wheeled velocipede by adopting the spider wheel and ball bearings, and the rotary pedal action. In these machines the pedals actuated a toothed wheel, which communicated the motion by a chain to another toothed wheel on the axle of the driving wheels. By varying the proportion of these chain-wheels, a small wheel is made equal in velocity to a larger one, and this is termed the "gearing" of the machine.

Next came the sociable, but, on account of its weight and cumbersomeness on the road and in stabling, it was soon displaced by the tandem.

The velocipede, known as a safety bicycle, has two small wheels of the same size (or nearly so), the rider sitting well back from the front wheel, and thus possessing greater security from falling forward, and the requisite velocity is attained from the small wheels by the principle of "gearing up," adopted from the tricycle, the various classes of machines thus appropriating improvements from each other. One of the latest forms is a tandem bicycle, sometimes carrying six, or even ten persons. At the present writing a chainless "wheel" has just been brought out. The bicycle having been found available for military service, there are now to be found in many countries completely drilled and equipped bodies of soldiery,

A HYDROCYCLE.

whose transportation is accomplished by its means.

This new method of giving wings to human feet has established wonderful records of speed. A late record is a mile in a little more than one minute. Another record is 616 miles and 340 yards in twenty-four hours. And still another—100 miles in 3 hours 25 minutes and 53 3-5 seconds. In December, 1897, in New York, Miller accomplished 2,090 miles in six days. This beats the speed of "Mercury new-lighted on a heaven-kissinghill," and would have been little less than a miracle a hundred years ago.

Besides the wonderful speed of record-makers and record-breakers, the "wheel" is coming into almost universal use, and men and women by thousands are becoming practically independent of street-cars, railways, and horses, and for business or pleasure are adopting it more and more.

Before the discovery of rubber, or the invention of the perfect tools and machinery which have been evolved within fifty years, no inventor, however ingenious, could have produced the modern bicycle. It embodies the inventions and adaptations of hundreds of skillful men, besides those who have improved the "wheel" and brought it to its present degree of perfection. The application of ball-bearings and rubber tires completed the development of "the wheel." It was first made in quantities in 1875, in Hartford, Conn., and in 1890 a capital of $2,058,072 produced an annual product of $2,568,326. The first tricycle was made in 1864.

The invention of the rubber tire, and then of the hollow pneumatic tire, gave a great impetus to the manufacture and use of the wheel.

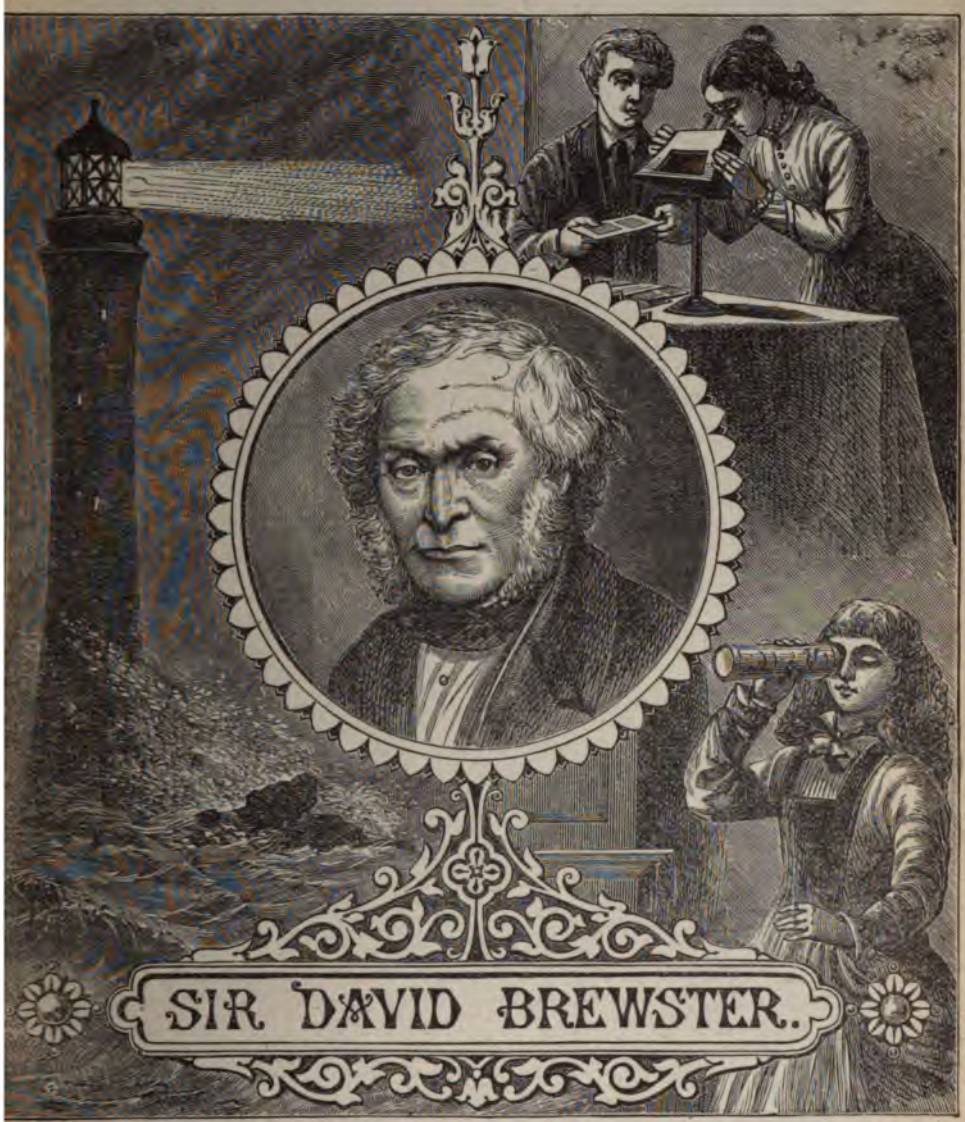
The year 1897 gave the hydrocycle, the electro-magnetic bicycle, the bicycle air-ship, the bicycle health motor, the railroad bicycle, the water bicycle, and several other curious devices and appliances, all based on the original hobby-horse of our forefathers.

In 1845 an Englishman named Thompson patented the first pneumatic tire. This was long before the age of bicycles, and hence the patent was consigned to oblivion, as well as the inventor, until the bicycle mania, when this patent was unearthed and found to contain all the essential elements of the pneumatic tire now in general use. The most serious objection to this tire is its liability to puncture. Many efforts have been made to overcome this objection, but without success, either from a failure to accomplish the purpose, or from deleterious effects produced in the tire in other respects by the method adopted, and until the present time no means of accomplishing this purpose in a satisfactory manner have been devised. A recent patent, however, by U. P. Smith, Chicago, has been obtained in the United States and in several foreign countries, which appears to solve this very difficult problem, for it not only automatically closes all ordinary punctures, but preserves its resiliency and enduring qualities,

and even enhances them. The invention relates especially to double-tube tires, although it can be successfully applied to single tubes. The method of constructing the air-tube for this tire is as follows: An ordinary vulcanized air-tube is immersed in benzine, gasoline, benzole, or some other kindred substance, and allowed to remain therein from twenty to thirty minutes, when it becomes expanded to nearly double its normal size, not only in diameter, but in length and thickness as well. This expanded tube is then placed on a pole or slipped over an expansible casing which when inflated will fill the expanded tube, and retain it in position until it has time to thoroughly dry; after the expanded tube has been so fixed on a pole, etc., a strip of cured rubber in its normal condition of a width, length and thickness sufficient to make a complete tube is cemented to the expanded tube, and allowed to remain until the expanded tube becomes thoroughly dry, when the combined tube and healing strip is pulled off the pole or inflatable tube over itself, turning the tube inside out, and throwing the healing strip on the inside of the tube. The ends are then united by the usual process, if an annulus tube is desired, and if not, the ends are sealed up in the usual method. The air valve is then fastened to the tube, and it is ready for the wheel. The expanded tube, as it dries, attempts to contract, but is prevented by the pole. As soon as the tube is removed from the pole it attempts to contract to its normal size, and does so to the extent permitted by the resistance of the healing strip that has been cemented thereto; this contracts or compresses the healing strip in all directions, and causes it to become somewhat thicker, but narrower and shorter than it was in its normal condition. The tube holds the strip in this compressed condition, so that any puncture made in the strip at any point, the rubber at once closes by pressing in upon the hole from every direction, in precisely the same way as a hole in a rubber stopper will be closed by pressing the stopper into the nose of a bottle. In this way perfect uniformity of pressure is secured, and from every possible direction, and without any further labor than cementing the two layers of rubber together. The process has several modifications, which may be adopted. It is nature's process, and like all the works of nature, is more perfect than the hand of man alone can possibly accomplish; and a pneumatic tube is secured that is proof against leakage in case of puncture: that is resilient and lasting, and may be no heavier when completed than the present air-tube, if desired, or may be made heavy and thick enough for use upon the heaviest vehicles, and at a moderate cost.

SIR DAVID BREWSTER.

[Born 1781. Died 1868.]



Sir David Brewster's claim to distinction rests chiefly on his course of original discovery in the science of optics. This throws an interest over his whole life. As a child he enjoyed great advantages, his father being a teacher of high repute and rector of the grammar school at Jedburgh. In his boyhood the bias nature had given him for physical pursuits was fostered by his intimacy with a self-taught mathematician, astronomer, and philosopher, James Veitch, of Inchbonny.

CHAPTER XVI.

WATCHES AND CLOCKS.

THE MODERN WATCH—THE ELGIN—THE WALTHAM—THE STEM-WINDER—THE WOODEN AND BRASS CLOCK.

AT the beginning of this century all watches were made by hand, and no part of one watch would fit another. But about 1850, Howard, an ingenious Yankee, struck the idea of having all the parts made by machinery, so that any piece of one would fit another equally well. This revolutionized the manufacture, and drove it from private workshops to immense manufactories. So perfected is the trade that a girl can make the screws of which it takes 150,000 to weigh a pound. Formerly an English watch consisted of 800 pieces. Now a Waltham or Elgin has less than 160 parts—one-fifth as many. The improvement in watches has kept pace with all other progress.

Since 1880 non-magnetic watches have been manufactured. Watches are perhaps no better than they were a century since, but manufactured in watch factories, they are produced at prices that bring them within everybody's reach. As any piece will fit in any one of thousands of watches, and as the parts are kept in stock by repairers, the cost of repairs is almost nothing compared with former days. The stem-winder was invented in the sixties, in Switzerland. The Waltham and Elgin watches are exported to all parts of the world. At the beginning of the century a bungling contraption was bequeathed from sire to son, but now every member of the family may possess an elegant time-piece, whose beauty is equal to its utility.

Clocks are now made by machinery, springs taking the place of pendulums, and hundreds of thousands of brass or wood are produced in factories at prices that once would have seemed impossible. After considering for generations that a pendulum was a necessity, some Yankee found that a spring would run a clock as well as a pendulum, and thus came the neat and cheap little clocks of today, superseding the clumsy ones of the last century.

Recently H. J. Davis, Edmond Kuh, and others have invented improved escapements. James Bogardus (1800-1874) invented a three-wheel chronometer clock, in 1828; in 1831 an engraving machine to make watch dials. He was author of a great variety of inventions. The chronometer as used on board ship, and by astronomers, was a vast improvement on all timekeepers in use until within a few years.

A hundred years ago "the old clock on the stairs," or in the corner of kitchen or hall, cost nearly or

CHAPTER XVII.

PHOTOGRAPHY.

THE MARVELOUS DISCOVERY OF THE ART OF TAKING SUN PICTURES—DAGUERRE—REVELATIONS OF ASTRONOMY BY THE CAMERA—THE SPECTROSCOPE—THE STEREOPTICON—THE KINETOSCOPE—ROENTGEN.

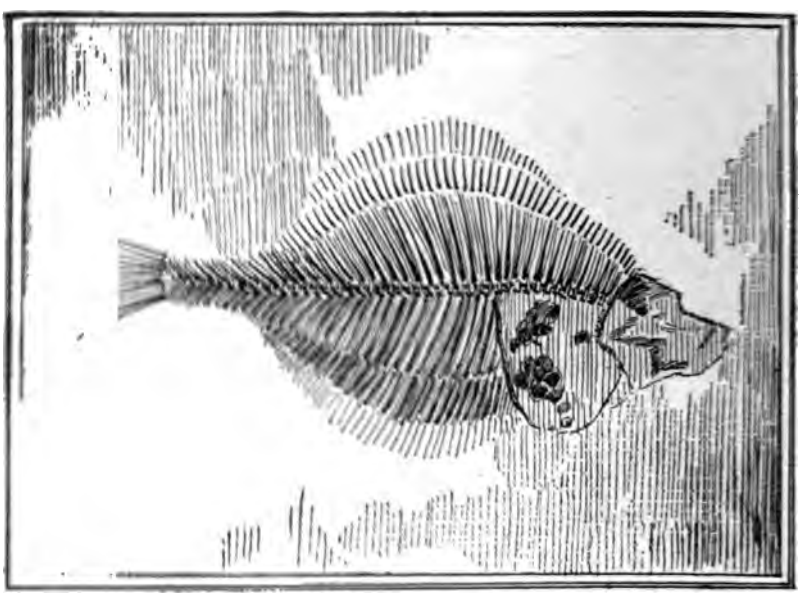
WHEN the Nineteenth Century dawned, the only possible way in which the pictures of loved ones, and the portraits of the great and good, and the works of art and nature, could be reproduced and preserved, was by the pencil and brush of the painter's art. The miniature or larger likeness was delineated by brush and pigments only, and the widely differing portraits of the celebrated men and women, anterior to photography, whose alleged pictures survive, convince us that we can have no assurance of their accuracy; and, as it required genius of a high order to paint the face correctly, only the rich could command the requisite skill. A hundred years ago not a daguerreotype or photograph existed, nor was the art preservative of all life and scenery dreamed of. Even little more than fifty years ago, on the very eve of the great discovery, there was no thought of what was so soon to burst on an age that prided itself on its advancement. It came almost by accident, and yet could only have come through scientific attainments, supplemented by observing eyes and reflecting minds.

On one of the simplest facts in chemistry—for photography is the daughter of chemistry—is founded one of the most interesting and valuable discoveries of all time, the "art of producing the pictures of objects by the action of light on chemically-prepared paper, silver, glass, etc., or the art of receiving and fixing on such surfaces the images formed by the camera."

The ancient alchemists had noticed the action of light on certain substances, and the Pomeranian chemist, Sheele, (1742-1786), in 1777 observed the effect of sunlight on silver compounds, and that the darkening was from the violet end of the solar spectrum. Acting on this hint, Josiah Wedgwood, son of the original manufacturer of the famous earthenware which bears the family name, who was the originator of "queensware," in 1802, obtained pictures of objects produced by the action of light on nitrate of silver on leather. But he found no way of rendering the pictures permanent, notwithstanding he was aided by Sir Humphrey Davy. But Sir John Herschel suggested the use of hyposulphite (thiosulphate) of soda, a salt now used for the same purpose.

Berzelius, the Swedish chemist, announced to the world a little later a large number of compounds that are changed by the action of light. In 1804, Dr. Thomas Young (1773-1829); in 1809, Joseph Louis Gay-Lussac (1778-1850) and Louis James Thenard (1777-1857), and in 1812 Dr. Beard, made discoveries on the frontier of this great invention—perhaps suggested and inspired it, but it was not until later that Joseph [illegible] Niepce (1765, 1833), a [illegible] produced permanent [illegible] He used bitumen or as[illegible] sensitize surfaces, but [illegible] several hours [illegible] process was too long [illegible] invention of value. [illegible] process heliography. [illegible] partner with Daguerre [illegible] before the process [illegible]

The actual discoverer was no doubt Louis Jacques Mande Daguerre, born in 1787, at Cormeilles, France, died at Petit-Brie-sur-Marne, in July, 1851. He was a scene and panorama painter, and inventor of the diorama, and followed this business until 1839, when he formed a partnership with Niepce. Notwithstanding the claim of some that Niepce was the real inventor, the fact that his son allowed the invention to go forth under Daguerre's name, that the two received annuities from the government, Daguerre of six thousand, and Niepce of four thousand francs, and that he was placed in the Legion of Honor, substantiates his claim. Daguerre reduced the time of exposure of the plate to twenty minutes.



PHOTOGRAPHING THE BONES OF A FISH BY MEANS OF THE X-RAY.

To show how intense must have been the application of Daguerre, it

is related by J. B. Dumas, the great French physician (1800-1884), that at the close of a lecture in 1825, fourteen years before Daguerre had perfected his invention, a lady addressed him, saying: "Monsieur Dumas, I have to ask you a question. I am the wife of Daguerre, the painter. He has for some time let the idea possess his mind that he can fix the images of the camera. Do you, as a man of science, think it can ever be done, or is my husband mad?" "In the present state of our knowledge we are unable to do it," said Dumas, "but I cannot say it is impossible."

The next year after Daguerre's discovery (1840), Photography, technically so-called, was discovered by William Henry Fox Talbot (1800-1887). He employed a sheet of paper instead of the copper plate. The paper was covered with a salt of silver, and exposed in the camera, when the image was developed by a solution of gallic acid, and multiplied by printing. The surface became the recipient of a latent image, which was developed, and afterward fixed by hyposulphite of soda. This is the basis of the present photographic process.

At first writing paper was coated with a solution of common salt, and after drying was brushed over with silver nitrate; by this means silver chloride was obtained, with a slight excess of the nitrate, in which condition it proved exceedingly sensitive to light. Various bodies, such as lace and fern, were laid on this paper, and a reversed fac-simile of them in black and white was produced; and the impressions were fixed by solutions of bromides and chlorides. When such a reversed fac-simile was placed over similarly prepared paper, and the light was allowed to act through it, the result was the formation of a fac-simile, only this time not reversed in shades. Talbot patented his process in 1841, which he called the Calotype, but it is generally and properly known as the Talbotype.

The distinguished Dr. John William Draper, chemist, physiologist, author of "Conflict Between Religion and Science" (1811-1882), produced the first photograph-portrait in this country in 1839. The daguerreotype was therefore destined to be superseded by a less cumbersome process. It required a copper plate silvered on one surface, which was polished and exposed to iodine vapor until yellow, when it was exposed in the camera, and then in a dark room immersed in a vapor of mercury. After the picture was developed it was immersed in hyposulphate of soda and washed in pure water, and the picture was completed. It was not a negative, but a picture, and each plate had to be manufactured by itself.

A great advance in the art of photography was made by Scott Archer, in 1851, in the discovery of collodion, a solution of gun cotton in alcohol and ether. Poured on a glass plate the alcohol and ether evaporate, leaving a thin film, which is subjected to a bath in a solution of nitrate of silver, and exposed to light in the camera. The picture is developed by chemical agents, and

fixed in the same way. This constitutes a negative, on which sensitized paper is laid and exposed to the sun.

Subsequently metal plates and gelatine films were adopted and ferrotypes and tintypes came, and then the multiform "kodaks" and cheap cameras placed the invention in the hands of thousands of amateurs, who have reproduced almost everything in art and nature. The daguerreotype on metal and the ambrotype on glass were superseded by the photograph, a great improvement on the daguerreotype, but the glory of the invention rests on the name of Daguerre, who saw the solar ray fall on chemicals on his study table, through an aperture in the shutter of the darkened room, and all that follows dates from that passing image. When all that has thus far been achieved in this art is considered, it may be said that, though photography may not be the most useful, it is the most wonderful discovery of the Nineteenth Century.

The sensitiveness of gelatine plates, a process which is at the bottom of most photographic processes, is so great that photographs of express trains in motion, leaping horses, and birds on the wing are of everyday occurrence.

The application of photography to astronomy has been attended, of late years, with truly remarkable results for we have now pictures of every object in the heavens, from the nebula in Orion to the spots upon the face of the sun himself. Even photographs of sound waves have been exhibited.

The marvelous pictures of the heavenly bodies, produced by photoheliography, could never have been conceived by Daguerre. Indeed it is doubtful if all the possibilities of his discovery are as yet dreamed of. (See "Astronomy.")

In 1851, Berkowsky daguerreotyped an eclipse of the sun. In 1860 De La Rue procured photographic views of an eclipse, and Prof. Bond, of Cambridge, Massachusetts; Lewis M. Rutherford (1816), of New York; Prof. Lewis Swift (1820), formerly of Rochester, New York, now of Pasadena, California, the distinguished "comet-finder," and others, have made and are making wonderful discoveries. Prof. George E. Hale, of Chicago University, has made marked improvements in astronomical photography.

The self-registering instruments that photograph the facts of meteorology, biology, physiology, and astronomy are invaluable. Stars are photographed that no eye has ever seen. But the delicate surface of the plate in the camera catches and retains their images. The first photograph of a fixed star was taken in 1850.

The process of Rutherford's researches is similar to that pursued by others in celestial photography. The views of large stars, taken after a short exposure, all appear like small round points that can only be seen through a magnifying glass. In the case of a long exposure their size depends, fundamentally, on the more or less strong vibrations of the atmosphere, which occasion the flickering of the stars. Stars of the ninth magnitude can be photographed

THE ROENTGEN RAY.

"Is capable of making a photographic record through everything, from a hand to a cameo."

AN X RAY LABORATORY.

with an exposure of eight minutes; these stars are ten times weaker than the faintest that can be detected on a clear night by the naked eye, and their images are very small points. It would be difficult to distinguish these small points from dirt spots on the plate. To do this, Rutherford makes use of an ingenious process. He brings the telescope, after the first exposure of eight minutes, into a slightly different direction, and makes another exposure of eight minutes while the clock-work continues to operate, and moves the telescope correctly in this second direction. In this manner two images are obtained of every star on the plate, closely adjacent; the distance and the relative position being in all the same. These double views can easily be found on the plate and distinguished from spots. If the telescope stops, it is evident that the images of the stars make a movement on the plate, the bright stars describing a line. This line is of great importance to determine the direction from east to west on the plate. For faint stars, which leave no line, a third exposure is necessary to determine this direction; the same thing takes place after the clock-work of the telescope has been stopped for some minutes. Rutherford has already taken numerous views of the stars, and they will serve as important means of comparison, after the lapse of centuries, in order to discover what change has taken place in the position of the fixed stars.

To-day there are patient watchers at every telescopic eye-piece in astronomical observatories, watching the heavenly bodies, and photographing their every movement, and with facilities surpassing those possessed by the ancient seers, they not only call by their names Arcturus and Orion and the multitudes of the starry sisterhood, but record the very motions they make as they waltz along the spaces of the firmament.

In 1840, Dr. J. W. Draper (1811-1882) daguerreotyped the moon; in 1851 Professor W. C. Bond (1789-1859) produced lunar photography. Dancer, P. A. Secchi (1818-1878), Crookes, Higgins, Phillips, W. De La Rue (1815-1889), Fry, Rutherford, and multitudes of star-gazers are recording and have noted celestial phenomena, and have extended astronomical knowledge to the ends of the earth. Comets, nebulæ, meteorites, and even the aurora borealis and the lightning, have been caught and pictured.

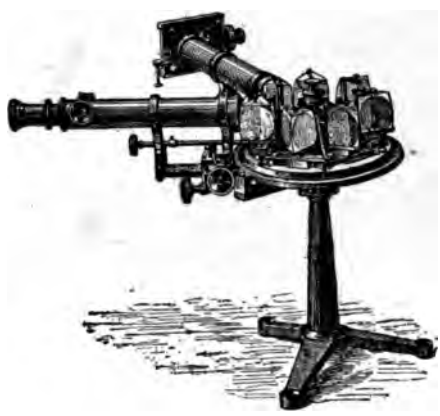
The use of photography in the army, in medicine and surgery, in commerce and the arts, is beyond description, and is increasing with every year. A curious toy at first, it is now a great agent in a hundred departments, and all its achievements are within the "Century of Centuries."

The achievements of the spectroscope have been marvelous. William Hyde Wollaston (1766-1828) had observed, in 1805, and Joseph Fraunhofer (1787-1826), in 1815, the dark lines in the solar spectrum. It was theorized that these lines denoted the existence there of the different chemical elements. The spectroscope demonstrated the accuracy of the scientific guess. It revealed

the elementary constituents of the sun.

By the aid of photography the evidence was preserved, and now the elements that compose the sun, the stars, and the planets, are known, for the smallest quantity of any element at any distance is indicated by the lines in the spectroscope. It is one of the most surprising of the discoveries of the century that the exact constituents of the distant stars can be known.

Microscopic photography has accomplished marvels beyond belief. I have owned pictures of landscapes in which I could count the rocks in a stone cabin, and distinguish the articles in a woman's dress, and recognize the likenesses of several persons, or distinctly read the Lord's prayer by placing under a compound microscope a picture that the head of a pin would entirely cover. In the siege of Paris, in 1870, whole newspapers were microscopically reduced, on collodion films, and sent by carrier pigeons to remote distances where they were magnified on screens by magic lanterns, and read and copied.



THE SPECTROSCOPE.

Collateral to the art is the stereoscope, projected by Professor Elliott, of Edinburgh, in 1839, later by Sir Charles Wheatstone, and perfected by Sir David Brewster, in 1849. It gives a flat picture the appearance of a solid object. Perception of perspective, and what is termed the solidity of an object, depends on the fact in consequence of the distance between the eyes, the right eye sees part of the object, which is invisible to the left eye, and vice versa, the two separate images being combined by the brain into one impression. When a picture is viewed with one eye alone, the effect of perspective to a great extent vanishes. The stereoscopic effect is also lessened by distance. In order to obtain a due effect from a stereoscopic slide, two pictures are necessary, one representing the object as seen by the right eye alone, the other representing it as seen by the left eye alone, and these pictures must be so arranged that each eye sees only the corresponding picture. Brewster's stereoscope consists of a box, divided by an opaque partition down the middle, the slide being placed at the bottom of the box, and then viewed through a pair of half lenses or prisms, which act upon the light rays, proceeding from the pictures in such a way that the virtual images of the two pictures are coincident in position; the two images are combined by the brain into one impression; and the appearance of solidity of the scene or object is accurately reproduced.

The stereopticon is the magic lantern improved, and adapted to the photographic slide, which is magnified and thrown on a screen, and the details so brought out by the limelight, as to render the most elaborate architecture, the minutest landscape features, in fact, all the particulars of any real scene as vividly portrayed as in the scene itself. It is one of the great educators of the people. Foreign cities, scenery, works of art, are brought to those who otherwise would never obtain adequate impressions of them. It is almost a substitute for foreign travel, and is a happy illustration of the mountain coming to Mahomet, when "Mahomet could not go to the mountain."

One of the latest (not the last) wonders at this writing is the "Kinetograph," "Kinetoscope," "Vitascope," etc. The successive stage of any movement, the march of a detachment of cavalry, a train of cars, any moving scene, is reproduced in a series of instantaneous views, which are so placed side by side as to form a continuous picture, an exact reproduction of the original scene, and these are thrown upon a screen with such fidelity that it is impossible to realize that one is not looking at actual life, and not its counterfeit. So rapidly does this machine work that every motion of a dancer's feet, every twist or turn of a club-swinger's wrists and arms are reproduced. The impressions are taken on a long strip of gelatine film with such rapidity and accuracy that not the faintest motion is missed.

The Kinetoscope is an apparatus for exhibiting the pictures taken by the Kinetograph. The Kinetoscope displays the pictures to the eye, one after another, so rapidly that they all seem like one scene, with the figures moving about as they do in actual life. The Kinetograph records forty-six photographs in a second, and the Kinetoscope reproduces them. They were invented by Edison in 1894. Their combination was effected in 1895 by W. K. L. Dickson.

This process has demonstrated the accuracy of the eyes of the ancient Greek artists, whose statues represent the legs of a horse elevated from the ground on the same side at once. It also overthrows all previous notions in regard to the movement of a horse in a trot or gallop. Painters have hitherto represented the horse at a gallop as if his fore and hind legs were in the air; the former pushed straight out level with the body, the latter extended in the same way to the rear. These instantaneous views have shown that a horse is never in such a position, and that the only time when he has all his legs off the ground is when they are doubled up under him. One of the pictures represents the "Empire State Express." It shows at first the train in the distance, the stretch of track being considerable. Several laborers are at work on the roadbed, and as the train approaches they step aside, one or two of the men pausing to strike a farewell blow. Then the great monster comes rapidly nearer, and there is a splash of spray from under the tender as the engineer takes water into

his tanks from the little runway between the tracks. And finally, the monster sweeps down upon you with such overpowering realism that one feels quite like getting out of the way. As the train, seemingly almost fullsized, plunges across the scene, the porters in their white suits are seen waving their towels from the doors of the vestibule, and even the passengers' faces are plainly seen at the windows.

Carbon printing is a photographic process, invented by Pouton, in 1838, and introduced by Poitevin in 1855. It is as follows: Paper is coated with a compound of bichromate of potassa, gelatine, and lampblack, in cold distilled water; this is allowed to dry in a dark room, subsequently exposed between a negative for a few minutes, according to the character of the solution and of the light, then dissolving off with hot water the parts not affected by the actinic action of the light. The picture resulting from this treatment is a positive print in black and white, of which the shades are produced by the carbon of the lamp-black. Poitevin later introduced another process for carbon-printing under a positive. The paper is floated in a bath of gelatine dissolved in lukewarm water and colored with lampblack. Such paper is sensitized in a dark room by immersion in a solution of sesquichloride of iron and tartaric acid. This renders the gelatine insoluble, even in boiling water. The sheets are dried and exposed under transparent positives in the printing frame. The parts of the film acted upon by light become soluble in hot water, the iron salts, under the influence of light, being reduced by the tartaric acid, restoring the organic matter to its natural solubility. The sheet is then washed in hot water, which removes the ferruginous compound and develops the picture. Improvements were subsequently introduced by Swann and others.

William Conrad Roentgen (1845). The X-rays, or Roentgen rays, were first made known to the world by their discoverer in 1895. (See "Electricity.") He is a profound investigator, whose great discovery bids fair to revolutionize medicine and surgery. The rays not only penetrate wood and other substances, and produce photographic results beyond, but they penetrate with ease human flesh. That the new photography has suddenly arisen which can photograph the bones, and the organs of the human body; that a light has been found which can penetrate, so as to make a photographic record, through everything from a purse or a pocket, to the walls of a room or a house, is news which cannot fail to startle everybody. That the eye of the physician or surgeon, long baffled by the skin, and vainly seeking to penetrate the unfortunate darkness of the human body, is now to be supplemented by a camera, making all the parts of the human body as visible, in a way, as the exterior, appears certainly to be a greater blessing to humanity than even the Listerian antiseptic system of surgery; and its benefits must inevitably be greater than those conferred by

Lister, great as the latter have been. The results of surgical operations under the new system are growing

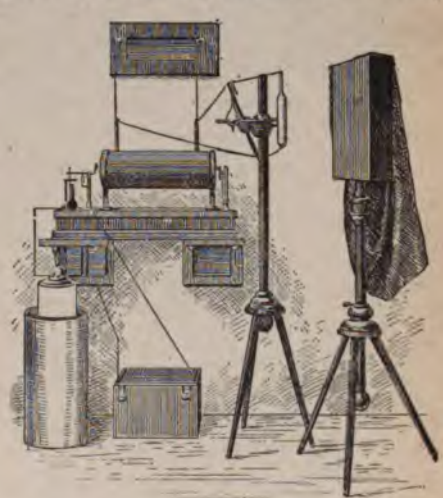
WILLIAM CONRAD ROENTGEN.

voluminous. In Berlin, not only new bone fractures are being immediately photographed, but joined fractures, as well, in order to examine the results of recent surgical work. In Vienna, imbedded bullets are being photographed, instead of being probed for, and extracted with comparative ease. In London, a wounded sailor, completely paralyzed, whose injury was a mystery, has been saved by the photographing of an object imbedded in the spine, which, upon extraction, proved to be a small knife-blade. Operations for malformations hitherto obscure, but now clearly revealed by the new photography, are already becoming common, and are being reported from all directions. Professor Czermark, of Graz, photographed the living skull, denuded of flesh and hair, and has begun the adaptation of the new photography to brain study.

The latest camera has been evolved (1899) by William Gaertner, of Chicago, for the Smithsonian Institution. It has attained marvelous rapidity, producing a negative in one sixth-hundredth of a second. Progress in photography has almost shelved the collodion plate, and made the use of dry plates susceptible to second and half-second exposures so simple that a child can make a picture.

"The Art of the Sunbeam" has superseded silhouettes, or profiles cut from white paper, with black silk or paper background. This is all the likeness preserved of many who left earth before the daguerreotype came.

It is curious to note how inventions and discoveries have come in to reinforce one another. Iodine, on which photography depends, was only discovered in 1811; bromine, the only



AN X-RAY APPARATUS.

other equally sensitive substance, in 1826; gun-cotton and chloroform, that produce collodion, were not

known till 1851, and gutta-percha, which insulates and encloses submarine telegraphic wires, was not known until just when it was needed to perfect the ocean cable.

The great desideratum of the art has been the ability to photograph color. It has long been an "iridescent dream." Sir John Herschel thought he had obtained the colors of the solar spectrum on sensitized paper. Becquerel and others were equally sanguine. Every now and then it has been announced that some one has succeeded in photographing color. The hope has always been "hope deferred." So far the obstacle seems insurmountable. And yet "impossible" should not be written over that grand result. Far less marvelous seems that possibility than what has already been accomplished. From the dictionary of science the word "impossible" has been expunged.—So far had we written, in the end of 1898, when lo, the "impossible" had arrived. Color photography was accomplished. The process of using an ordinary camera and in one-fifth of a second accurately photographing all the brilliant hues of a flower garden, the contrasts in green of a landscape, the wonders of a summer sky, the jewel upon your finger, the ribbon at your throat, the stripe in your clothes, the decorations of your hat, the bouquet on your lapel, was declared to be successful. The inventor is James W. McDonough, of Chicago (1898). Patents have been granted by the United States, England, France, Belgium, Austria and Germany. A contest was precipitated by Joly, of Dublin, Ireland, who had pursued the same lines, but the final award was to McDonough.

In astronomy the color-work of McDonough is already in experimental use at the Yerkes Observatory at Williams Bay, Wisconsin. Of the McDonough sensitive plates Professor George E. Hale, director of the observatory, writes: "With their aid I have been able to photograph for the first time the red portion of the spectra of very faint stars, and it is easy to see that plates of this character will prove invaluable in both solar and stellar spectroscope investigations. The possibility of photographing the red region of stellar spectra opens up an immense field of research hitherto unexplored."

It will revolutionize the art of book and magazine illustration.

The McDonough process of color-photography is purely mechanical. The ordinary camera is used and the negatives are produced and developed by the usual processes; but before exposing the negative in the camera, a transparent screen ruled with the three primary colors, red, blue and green (yellow is no longer a "primary"), is interposed between the negative and the object to be photographed. After developing the negative a positive plate is produced from it, which, viewed by itself, does not differ from the ordinary black and white plate; but when it is laid upon a viewing-screen ruled with the primary colors (being a duplicate of the taking-screen used in the camera), the colors in the object photographed appear. In the

preparation of these screens a ruling machine is used so finely adjusted that the colors are laid in the lines of from 300 to 1,500 to the inch with perfect regularity on paper, glass or mica, and so delicate is the operation as to require the use of a microscope magnifying sixty diameters.

The Chromatic shutter is another evidence of McDonough's rare inventive genius. By its use the rays of light, as they enter the lens of the camera, are accurately measured and adjusted to the varying densities of the fundamental colors of the screen. This invention alone makes the name of McDonough illustrious in the photographic world, and is considered one of the greatest inventions made in the last twenty-five years in photography.

There are many useful ends to which photography contributes that there is not space here to chronicle. It has already popularized what before was the exclusive possession of the favored few.

It has been well said "it cherishes domestic and friendly feelings by its ever present transcript of the familiar faces, keeping fresh the memory of the distant and the dead. It keeps alive our admiration of the great and the good by presenting us with the lineaments of the heroes, the saints, the sages of all lands. It gratifies, by faithful portrayal of scenes of grandeur and beauty, the eyes of him who has neither wealth nor leisure for travel. It has improved pictorial art by sending the painter to the truth of nature; it has reproduced his works with marvelous fidelity; it has set before the multitude the finest works of the sculptor. It is lending invaluable aid to almost every science. The astronomer now derives his mathematical data from the photograph; by its aid the architect superintends the erection of distant buildings, the engineer watches over the progress of his designs in remote lands, the medical man amasses records of morbid anatomy; the geologist studies the anatomy of the earth; the ethnologist obtains faithful transcripts of the features of every race."

Like most of the great discoveries this art is beneficent, and ministers to the welfare of mankind. It gives to the poorest the image of the loved one absent or "gone before;" it spreads on the printed page the exact revelation of the telescope or microscope; it faithfully reports the great pictures of artists which repose in galleries the poor may never see; it presents landscapes, buildings, scenes, that only the rich can visit. and so places within the reach of the great masses of the people what otherwise would be unattainable. It reinforces justice by placing in the hands of the law executors the likeness of the fleeing fugitive by hanging in every rogue's gallery the portrait of the criminal. It is the servant of art, nature, law, morality, one of the friends of man whose existence was unknown a hundred years ago, and it is a benefactor not only in the respects referred to, and many others, but it affords employment to thousands more than its invention deprived of occupation. In the place of here and there an artist it has opened avenues to hundreds

of thousands of operators, who find patrons among all classes. Its history is one of many illustrations that labor-saving inventions are not disasters. The cheapness of the product multiplies customers and demands producers, so that for every portrait painter it has deprived of employment, it has summoned a hundred operators. Photography, therefore, is an illustration of the fact that the discoveries and inventions of the age benefit the masses of mankind.

THOMAS ALVA EDISON.

[Born at Milan, Ohio, 1847.]

Those who have called Edison a mere man of expedients have failed to correctly gauge the caliber of his mind. Edison owes nothing to the schools, to society, or to patronage. He is a natural force, and as such has at last made his own way to universal recognition. Our Fultons, our Whitneys, our Morses, and our Edisons, all go to show that great inventors, like great poets, are born and not made, and that the New World is taking the lead in the grand march of progress.

CHAPTER XVIII.

ELECTRICITY.

VOLTA—GALVANI—MORSE—EDISON—TESLA—THE TELEGRAPH—THE TELEPHONE—BELL—GRAY—FARADAY—THE OCEAN CABLE—THE PHONOGRAPH—THE ELECTRIC LIGHT—THE ELECTRIC MOTOR—THE STORAGE BATTERY.

THE mysterious agent, Electricity, whose nature is as unknown as when it was only seen leaping in the clouds, has, during the Nineteenth Century, been tamed and harnessed by human ingenuity, until it has become man's most efficient servant.

It was early discovered that some substances could be made to attract objects when excited by friction. As amber, Greek *elektron*, was the most sensitive substance known, "Electricity" was the name given to this mysterious force, which has already become, and is more and more recognized as, the chief force in nature.

Ferguson says: "The best known theories treat it as a substance existing in the form of two fluids or one. In the former, every non-electrified body has an enormous and equal quantity of each of the electric fluids in it, and they are then said to be neutral, fixed or combined; so great is this quantity, that by no possible electrification can a body be deprived entirely of either kind. These fluids have no mass nor weight, nor any other property of fluids, save that of mobility, and attraction and repulsion. They are not confined to the molecules of the body, and can be separated—one fluid being drawn to one part of the body, and the other to the opposite. They may also pass from one body to another. The molecules of either fluid repel like molecules, and attract those of the other fluid, with a force varying inversely as the square of the distance between them. The single fluid theory supposes that all bodies are composed of two kinds of material particles—one ordinary matter, and the other electric fluid. The former has all the properties of matter; the latter has only mobility, and attraction, and repulsion. The particles of matter repel other particles of matter, but attract the particles of the fluid with a force varying inversely as the squares of the distance between the particles. The particles of fluid have similar properties; but the attraction between any given quantities of unlike molecules is slightly greater than the repulsion between the same quantities of like molecules when the other conditions are the same; consequently there is a slight resultant attraction between an amount of matter in combination with an equal amount of fluid, and another similar combination of matter and fluid. When

equal quantities of matter and fluid are present in a body, it is non-electrified, and the matter and the fluid are then said to be combined.

LUIGI GALVANI.

When more fluid than matter is present, the body is positively electrified; when there is a deficiency of the electric fluid, the electrification is negative."

For a long time electricity was only in an experimental stage. Sir Isaac Newton (1642-1727) in 1675 observed signs of electrical excitement in a rubbed plate of glass. Hawkesbee, who wrote in 1709, also noticed similar phenomena; and Dufay, in the "Memoirs of the French Academy," between 1833 and 1837, generalized so far as to lay down the principle that electrified bodies attract all those which are not so, and repel them as soon as they have become electric by the vicinity or contact of the electric body. Otto Guericke (1602-1686) had discovered that his sulphur globe, when rubbed in a dark place, emitted faint flashes of light, and shortly afterward it was noticed that a similar phenomenon occurred at the surface of the mercury when the barometer was shaken—a fact which one of the celebrated mathematicians, James Bernouilli (1654-1705) attempted to explain on the Cartesian system, but which was afterward correctly attributed by Hawkesbee to electricity. Stephen Gray (1729-1796) experimented with conductors; J. A. Nollet (1700-1770) soon afterward sent a shock along a line of men and wires; Watson (1715-1787), Bishop of Llandaff, in 1745 sent a shock through 12,000 feet of wire, and proved that it was practically instantaneous throughout its length. A writer in the "Scots' Magazine," in 1753, proposed a series of twenty-four wires, from the

NIKOLA TESLA.

ends of which were to be suspended light balls marked with the letters of the alphabet, or bells which were to be moved by an electric current

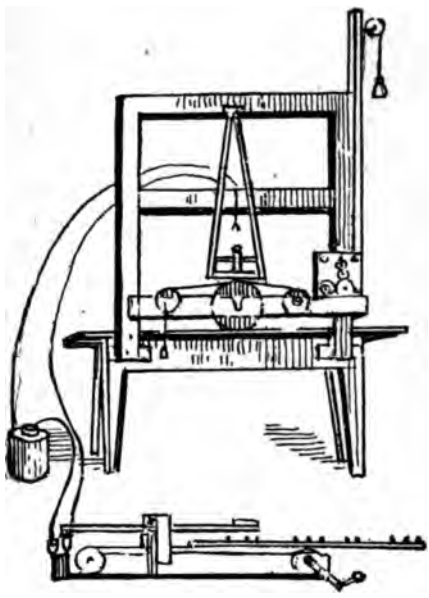
directed to the appropriate wire. George Louis Le Sage (1724-1803), at Geneva, in 1774, actually constructed a telegraph arranged in this manner, the end of each wire having a pith-ball electroscope attached.

TESLA PERFORMING AN ELECTRICAL EXPERIMENT.

Lomond, in 1787, employed a single wire, connecting an electrical machine and electroscope in each of two rooms, thus described by Arthur Young:

"In electricity he had made a remarkable discovery. You write two or three words on a piece of paper; he takes it with him into a room, and turns a machine enclosed in a cylindrical case, at the top of which is an electrometer, a small, fine pith-ball; a wire connects with a similar cylinder and electrometer in a distant apartment; and his wife, by observing the corresponding motions of the ball, writes down the words they indicate. From which it appears that he has formed an alphabet of motions As the length

of the wire makes no difference in the effect, a correspondence might be carried on at any distance." Reussord, in 1794, proposed the employment of letters formed by spaces cut out of parallel strips of tin-foil



FIRST TELEGRAPH INSTRUMENT.

pasted on sheets of glass, which would appear luminous on the passage of the electric spark. In 1795 T Cavallo (1749-1809) proposed to transmit letters and numbers by a combination of sparks and pauses. Don Silva, in Spain, appears to have previously suggested a similar process. Betancourt, in 1796, constructed a single line telegraph between Madrid and Aranjuez, a distance of twenty-seven miles, in which the electricity was furnished by a battery of Leyden jars, and the reading effected by the divergence of pith-balls.

The discovery of the Leyden jar is attributed to Cunæus, of Leyden, in 1746, who, while handling a vessel containing water in communication with an electrical machine, was surprised at receiving a severe shock. In 1800 Alessandro Volta (1745-1827) discovered the voltaic pile.

In the eighteenth century the names of the principal contributors to the advancement of electrical science are Newton, Hawkesbee, Dufay, Guericke, Cunæus of Leyden and Franklin, who, in 1747, pointed out the circumstances on which the action of the Leyden jar depends. Monnier, the younger, discovered that the electricity which bodies can receive depends on their surface rather than their mass, and Franklin soon found that "the whole force of the bottle and power of giving a shock is in the glass itself;" he further, in 1750, suggested that electricity and lightning were identical in their nature, and in 1752 demonstrated this fact by means of his kite and key. About the same time D'Alibard and others in France erected a pointed rod forty feet high

EDISON LISTENING TO HIS PHONOGRAPH.

at Marli, for the purpose of verifying Franklin's theory, which was found to give sparks on the passage of a thunder-cloud. Similar experiments were repeated throughout

Europe, and in 1753 Richman was instantly killed at St. Petersburg by a discharge from a rod of this kind. The Nineteenth Century may well be

BELL SENDING A TELEPHONE MESSAGE FROM NEW YORK TO CHICAGO.

called the Age of Electricity, especially the latter half, for discoveries and inventions have crowded one another, each more wonderful than its last predecessor. The beginning of the century scarcely prophesied the close.

The present telegraphic system seems due to accident. Arago says: "It may be proved that this immortal discovery arose in the most immediate and direct manner from a slight cold with which a Bolognese lady was attacked in 1790, for which her physician prescribed the use of frog-broth." The story goes: "The wife of Signor A. Galvani (1737-1798), the professor of anatomy at Bologna, being indisposed, her physician prescribed for her a dish of frog-broth. Frogs were accordingly procured, skinned, washed, and laid upon a table in the professor's laboratory, which appears to have served the double purpose as a room for scientific and culinary operations. One of the professor's assistants, who was engaged in conducting some experiments with a large electrical machine, which stood upon the same table, had occasion to draw sparks from the machine, and the wife of Galvani, who was present, was surprised to observe that every time he did so the limbs of the dead frogs, moved as if alive. She immediately communicated this strange incident to her husband, who repeated the experiment, with, of course, the same result. Greatly struck by the phenomenon, he determined to follow it up, and henceforth devoted himself to experiments on the electricity of animals with such zeal that, it is said, he became the terror of every frog-pond near Bologna. Another fortunate chance discovery rewarded his perseverance. Having

WIRELESS TELEGRAPHY.

prepared the hinder parts of several frogs for anatomical investigation, he passed copper hooks through part of the dorsal parts, which remained

above the junction of the thighs, for the convenience of hanging them up till they might be required for the purpose of experiment. In this manner he happened to suspend several upon the iron balcony in front of his laboratory, when, to his inexpressible astonishment, the limbs were thrown into strong convulsions." This he called "animal electricity," but Volta explained that the phenomena was due to the contact of iron and copper, and not to frogs' legs.

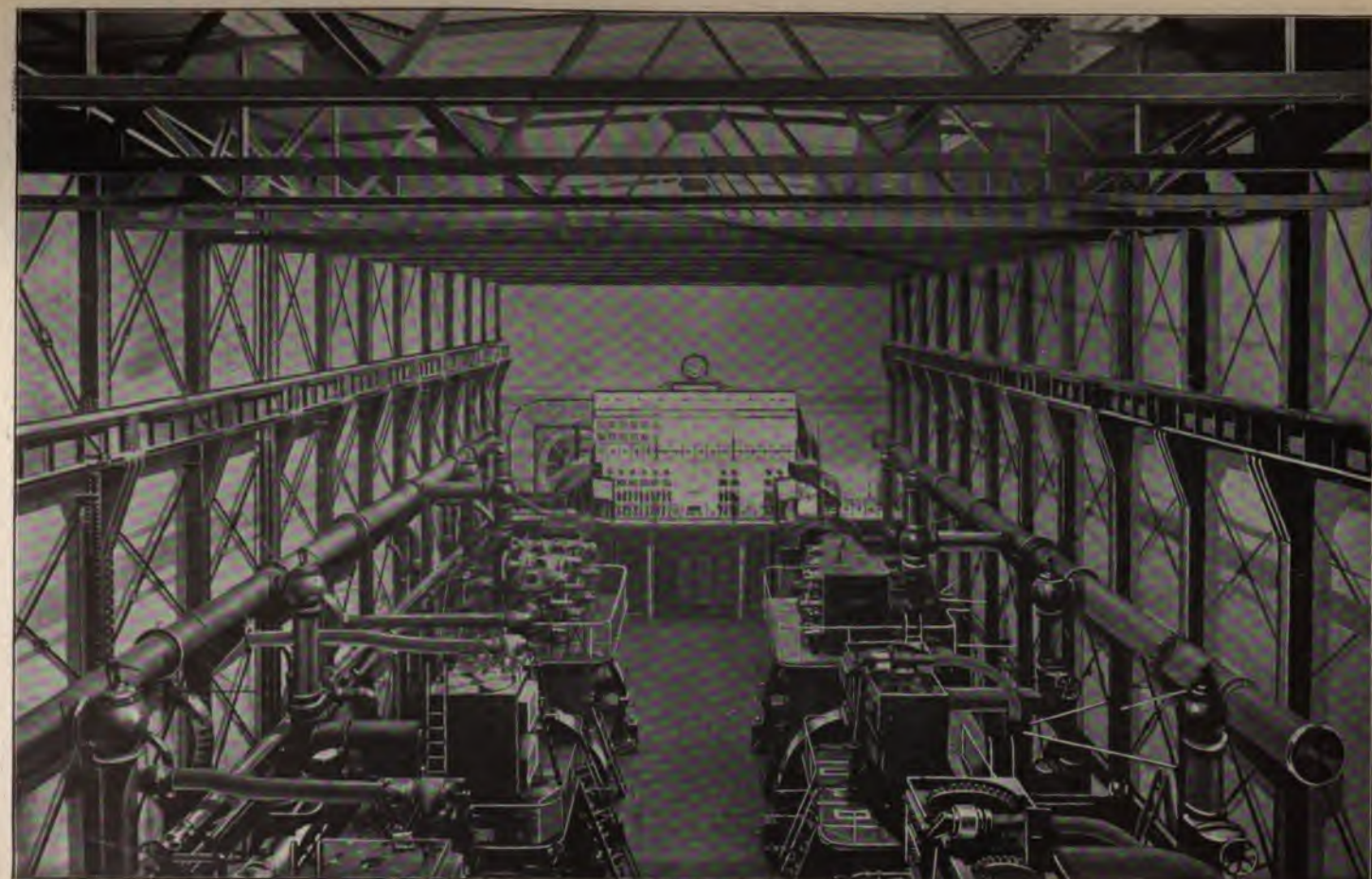
Next followed the discovery of electro-magnetism by H. C. Oersted (1777-1851), which was applied to the electric telegraph by A. M. Ampère (1775-1836), and was modified by G. T. Fechner (1801-1887), Richie, Alexander, etc. Oersted, in 1819, discovered electro-magnetism and the identity of chemical and electric forces. Ampère followed, correcting some of the errors of his predecessors, and in 1821 substantially anticipated the electric telegraph.

Bacon Schilling was the first to apply the discovery to telegraphy, and in 1835 Gauss and Wöher established communication between two points. James P. Joule (1818-1889), Steinheil, and others made valuable suggestions. Next year Munck, of Heidelberg, explained the process to W. D. Cooke, who, in England in 1837, with Charles Wheatstone (1802-1875), Ohm, Weber, Jacobi, Daniell, patented the first electric telegraph, and wires were laid on the London & Blackall Railway. Of Oersted's discovery, Professor Richard Owen (1801) says: "Nothing might seem less promising than Oersted's painfully pursued experiments with his little magnets, voltaic pile, and bits of copper wire. Yet out of these has sprung the electric telegraph." This was undoubtedly the first telegraph ever put to practical use.

All sorts of experiments were performed and theories announced, looking toward the coming era of electricity, from Franklin (1748) to Arthur Young (1787), then to Volta (1793), to Reusser (1794), to Don Silva in Spain about the same time, to Cavallo in 1795, to Sömmering (1809), to Oersted (1819). Hughes invented a type-printing telegraph, Alexander Bain invented the chemical telegraph, Bakewell the copying telegraph. Faraday, Wheatstone, and many others contributed to the evolution of the great discovery of Morse.

In 1811 Sömmering, decomposing water, managed to give distinct signals. In 1825 Sturgeon, of Woolwich, England, substituted soft iron for steel, the first appearance of the electro-magnet. It consisted of a bar of soft iron bent into horseshoe form, wound with a copper wire. In 1828 and 1829 Professor Joseph Henry (1799-1878), of Albany, N. Y., introduced a material improvement in the character of the electro-magnet.

In 1832 Professor Morse began to devote his attention to the subject of telegraphy, and in that year, while on his passage home from Europe, invented the form of telegraph since so well known as "Morse's." A short line worked on his plan was set up in 1835, in a room in New York, though it was



AN ELECTRIC POWER-HOUSE.

"Electricity has, during the nineteenth century, been tamed and harnessed by human ingenuity."

A HORSELESS CARRIAGE.

not until June 20, 1840, that he obtained his first patent. His first idea was to employ chemical agencies for recording the signals, but he subsequently abandoned this for an apparatus which simply marked on strips of paper the dots and dashes composing his alphabet. The paper itself is now generally dispensed with, and the signals read by sound —a practice which conduces to accuracy in transmission, as the ear is found less liable to mistake the duration and succession of sounds than the eye to read a series of marks on paper.

In 1834 Gauss and Weber made an electro-magnetic telegraph, sending signals by it in or near Göttingen for a mile and a quarter. In 1837 Steinheil, in Munich, and Wheatstone, in London, constructed telegraphs, the current in the former being produced by an electro-magnetic machine, and the latter by a constant battery. Morse is the father of the present commercial system of telegraphy. He constructed the first line over which an intelligible message was sent for any distance, the line being built from Baltimore to Washington, May 27, 1844. The first message, "What hath God wrought," was sent in 1843, by Professor Morse, to his assistant, Alfred Vail. The United States Government appropriated $30,000 to further the invention. An electric telegraph consists essentially of three parts: a circuit comprising a metallic connection between two places, a communicator for signaling between them, and an indicator for receiving them at the station to which they are sent.

In 1843 Cooke invented the suspension of wires on poles, with earthenware rings through which the wires pass.

It is only just to say here that the credit of Morse's invention was claimed by Dr. Charles T. Jackson, of Boston, who also claimed to be the discoverer of anæsthetics, in opposition to the claim of Dr. W. T. G. Morton. He crossed the Atlantic in the same ship with Professor Morse, in 1832, and he affirmed that he then "developed in conversation the essential and the peculiar features of the American telegraph, patented in 1840 by Professor Morse. Dr. Jackson also declares that in the spring of 1834 he constructed and successfully worked, and exhibited to Francis Alger and other friends, a telegraph combining the peculiar features of that which he had invented on the steamer 'Sully,' though he did not think it could be profitably brought into public use till the invention of the sustaining battery, in 1837, furnished the means of obtaining a long-continued voltaic current of uniform strength."

When Morse appeared with his telegraph before the United States Congress, at the session of 1842-1843, and a bill was reported appropriating $30,000 to test its merits, Representative Johnson, of Tennessee, moved that one-half should be given to the lecturer on Mesmerism; and Mr. Houston moved to include Millerism! The chairman (John White, of Kentucky) ruled the amendments in order, on the ground that it would require a sci-

entific analysis to determine how far the magnetism of Mesmerism was analogous to that to be employed in telegraphy. This wit was applauded, but the amendment was voted down, and the bill passed by 89 to 83.

In 1850, London and Dublin, and Dover and Calais were connected. In 1827 Harrison Gray Dyar had constructed the first known telegraph, on the Long Island racecourse. The messages were received on litmus paper, through wires. But for the practical difficulty of perfect and constant insulation, owing to the intense self-repulsion of mechanical electricity, and the reaction and retardation from induction currents in long lines of coated wires, this method would really constitute an economical and satisfactory medium of distant communication.

Modern researches in electrical science have multiplied the varieties of telegraph to an extent almost incredible. The principal systems now in use are the Automatic, the Dial, the Double Needle, the Duplex, the Duplex Bridge, the Differential Duplex, the Fac-simile, the Harmonic Multiplex, Hughes' Printing Telegraph, the Quadruplex, the Single Needle, Wheatstone's, the Writing Telegraph, and several systems for printing messages as received. The telegraph used principally in this country is the Morse.

It may be said with confidence, only of electricity, that nothing can excel it as a means of communicating intelligence, inasmuch as nothing can excel that which is instantaneous. In electricity man has reached the end of progress, and no future means of communication can surpass "the silent highway."

In 1854 Starke, Dr. Werner von Siemens, and Halske had each invented a method of sending two messages at the same time on the same wire — duplex. But it remained for Edison to produce the perfect method now in operation. Says the American Cyclopaedia: "The method invented by Starke, in 1854, and improved by Kraemer, Bernstein, Schreder, and other German electricians, consisted in employing a number of relays, and was only practicable on short lines. Proceeding by entirely original methods, Edison confined himself to two relays, avoiding by an ingenious device the obliteration of signals caused by changing the polarity of the current. By the contrivance of the electric-motograph, the most sensitive recording instrument ever invented, Edison gave to the world the duplex system of telegraphy, in a working shape, and rendered quadruplex, and sextuplex transmission possible."

A fac-simile telegraph was invented by F. C. Bakewell, England, in 1850. Also by Lieutenant Glen and Lieutenant-Colonel Melville, of the British Army. It is much in use in France.

Among the great electricians of Germany are George Simon Ohm (1787-1854), whose name is immortalized in the word "ohm," and Julius Reuter (1815), founder of telegraphy in Germany.

Werner von Siemens (1816), born

in Hanover, invented the process of electro-gilding, the differential governor, and the electric automatic recording telegraph. In 1847 he pro-

SAMUEL F. B. MORSE.

posed the application of subterranean electric conductors, insulated by gutta-percha; he invented a press, still used, for coating wires with gutta-percha. In 1848 he laid the first submarine mines for electric ignition to protect the harbor of Kiel from the Danish fleet. The same year he laid the first telegraphic line in Germany, between Berlin and Frankfort-on-Main, and the next year the subterranean line between Berlin and Cologne. He proposed the quicksilver unit by which exact measurements became possible; polarized relays; the electric railway; pneumatic despatch tube system, etc., etc.

In 1825 Wm. Sturgeon (1783-1850) invented an electro-magnet; in 1830 Professor Henry increased the magnetic force that Morse afterward used. The relay magnet was invented by Professor Henry.

Samuel Finley Breese Morse was born in Charlestown, Massachusetts, April 27, 1791, and died in New York April 2, 1872. He was a graduate of Yale College, after which he went to England, and studied painting under Benjamin West. He followed art successfully, but later became interested in electrical studies; and was possessed with the idea that he could construct a telegraph to be operated with electricity. The originality of his invention has been contested, but he is now regarded as the inventor of what, at the time, was the greatest discovery of the ages. The discoveries of Volta and Arago were being steadily advanced by Faraday, Steinheil, and Wheatstone; but to Morse belongs the credit of having perfected a method of recording upon paper at one end of a wire the characters formed by the operator at the other, by simply opening and closing the telegraphic circuit. Its merits were so evident that Pro-

CYRUS FIELD.

fessor Steinheil, with rare disinterestedness, wrote to his American rival that he had decided to abandon his own system in favor of that of

his distinguished confrere. Nothing, in fact, could be simpler than Morse's combination of the electro-magnet with his receiving instrument and manipulating key. "From the day that proclaimed Morse's telegraph to be an accomplished fact, honors were showered upon the illustrious inventor from every quarter; and long before his death, which occurred in 1872, Professor Morse was permitted, with rare good fortune, to realize how great were the benefits that had accrued not only to science but to the human race through his instrumentality. To-day an interruption of telegraphic communication is an interruption of the business of the world, which would be followed by results disastrous, not alone to commerce, with all its vast and varied interests, but also to the every-day wants of the people at large. As no other means of communication has ever performed such extensive or important functions as the electric telegraph is now doing, we cannot help regarding its discovery as the greatest step towards the universal brotherhood of nations that mankind has yet taken. Most truly has it annihilated space, and thus joined the hands of all peoples on the face of the globe in one grand, magnetic impulse towards a higher civilization, which, through instant interchange of deeds or ideas, is silently working out its promised fulfillment. Before this discovery Archimedes' boast fades into insignificance. With a spark Professor Morse has not only moved the world, he has illuminated it without other fulcrum than his own superior intelligence."

Charles Wheatstone (1802-1875) was one of the principal men of genius who made the electric telegraph practical for public uses. His claim of priority is disputed by Steinheil, of Munich, but the verdict of the world gives the great invention to Morse.

One of the most eminent scientists the world has produced was Michael Faraday, who was born in Surrey, England, September, 1791, and died at Hampton Court, August, 1867. He was of humble parentage, without educational advantages till he was thirteen years of age; and then, such as he received was what he gathered while serving as an errand boy in the shop of a book-binder and book-seller in London. Here he had access to some scientific works, among the most attractive of which were articles on electricity. He also, once a week, heard a lecture on natural philosophy, the expense of which—one shilling a week—was defrayed by his brother; and at about the same period he had the satisfaction of hearing four lectures by Sir Humphry Davy. He made notes of Sir Humphry's lectures, which he soon afterward extended, in a form as full as he could, interspersed them with illustrations from his own pencil, and sent the whole to Sir Humphry. The result was a very satisfactory one. He called on Davy, by invitation, and was at once made assistant in the laboratory of the Royal Institute, in 1813. He soon after traveled abroad with Davy, for a year and a half, acting as his

amanuensis and assistant in experiments. In 1813 he began those experiments that resulted in the great discoveries that rendered him the founder of the science of magneto-electricity. He succeeded in generating an electric spark by suddenly separating a coiled keeper from a permanent magnet. He subsequently discovered that an electric current existed in a copper disc rotated between the poles and a magnet. Says his biography, "The record of this work which he has left in his manuscripts and re-published in his three volumes of 'Electrical Researches,' will ever remain as his noblest monument; full of genius in the conception; full of finished and most accurate work in the execution; in quantity so vast that it seems impossible that one man could have done so much. Lastly, the circumstances under which the work was done were those of penury. During a great part of these twenty-six years the Royal Institution was kept alive by the lectures which Faraday gave for it. He had no grant from the royal society, and throughout almost the whole of this time the fixed income which the institution could afford to give him was 100 pounds sterling a year, to which the Fullerian professorship added 100 pounds more."

Faraday discovered electro-magnetic rotations, induction and, in 1830, "induce currents," and magneto-electricity in 1831, among the most prominent contributions to electrical science.

Contemporary with Faraday in England, was Joseph Henry in this country, who discovered magneto-electricity without knowledge of Faraday's discoveries, and also "Henry's coils," and self-induction. In 1831 he successfully worked an electric telegraph of his own construction.

In 1820 the arrival of a vessel was heralded as bringing news forty days later from Europe; and a Havre packet arrived, whose latest date was fifty-nine days old. These facts do not merely indicate the length of packet-ship transit across the Atlantic, but the want of postal organization, and the lack of trading vessels. The treaty of Ghent, between the United States and Great Britain, was concluded December 24, 1814—ten days before the battle of New Orleans. With present facilities the news would have prevented the battle, and Andrew Jackson would probably never have been president. The news did not reach the United States until the 11th of February following; a lapse of forty-nine days. In cases of difficulty among the nations of the earth, it may readily be seen how much broader are now the opportunities of diplomacy. The ambassador or envoy at London, at Paris, at Berlin, at Madrid, at Rome, at St. Petersburg, at Stockholm, at Constantinople, at Pekin, at Tokyo, can report within an hour or two of actual time, or seek and receive instruction in any important emergency; whereas in the olden time it might require three, or even six, months to determine his duty in the issue. And the more rapid communication between the merchants of either of

or all the continents results in more frequent and more rapid exchanges and the reduced cost of supplies. In fact, so rapid is telegraphic communication that a dispatch can leave London at 9 a. m. and reach New York at 7 or 8 o'clock—an hour or two before it starts—according to the watch!

Among those deserving prominent mention in this chapter are Strada, A. M. Ampère (1775-1836), M. A. Volta (1745-1826), William Thompson, J. F. Daniell (1790-1845), R. W. E. Bunsen (1811), Ruhmkorff, Apps, Gramme, Carcel, Fothergill, Cooke, H. F. L. Helmholtz (1821), Andrew Crosse (1784-1855), W. S. Harris (1792-1869), J. W. Swan (1827), C. F. Brush (1849), etc. The first newspaper report by telegraph appeared in the London Morning Chronicle, May 8, 1845. April 10th, the same year, a game of chess was played by telegraph.

One of the great triumphs of electricity is the submarine cable. The following resumé of submarine telegraphy will be interesting to the reader: In 1803, G. Aldini (1762-1834), a nephew of Galvani, made some interesting experiments in the transmission of electric signals under the sea near Calais, France. John Robert Sharpe, of England, transmitted electric signals through seven miles of insulated subaqueous wire, in 1813. In 1839, Dr. O'Shaugnessy, the director of the East India Company's telegraph system, transmitted telegraphic signals through insulated wires under the Hugli river, in India. Professor Charles Wheatstone, of England, suggested, in 1840, the practicability of connecting Dover, England, with Calais, France, by a submarine telegraph. In the United States Samuel F. B. Morse, in 1842, transmitted electric signals along a copper wire between Castle Garden and Governor's Island, in New York harbor. In 1843 Professor Morse suggested the possibility of connecting Europe and the United States by a submarine cable line. Meanwhile, Samuel Colt was operating submarine cables between New York City, Coney Island and Fire Island. In 1845 Ezra Cornell laid twelve miles of copper wire in the Hudson river, between New York and Fort Lee. The wires were insulated and inclosed in a lead pipe, and were successfully operated until they were destroyed by ice. In 1846 Charles West obtained permission from the British government to connect Dover and Calais by copper wire, and one year later J. J. Craven, of the United States, a resident of New Jersey, conducted a section of the New York and Washington telegraph line through the waters of a creek. The experiment was successful.

"In 1851 the first important submarine telegraph line was opened for business. It was laid by a company of English and French capitalists. The cable consisted of four copper wires, insulated with gutta-percha, surrounded by tarred hemp and protected by ten galvanized iron wires wound spirally around it. The weight of this cable was seven tons to the mile; it was twenty-five miles long, and was sunk in 120 feet of water. In 1853 six submarine cables

were laid, connecting various parts of England, Ireland and Scotland. In the following year five more cables were laid in Europe, the longest of which was sixty-four miles. In 1856 several cables were laid in waters much deeper than formerly. One of these, running from Spezia, Italy, to Corsica, weighed eight tons to the mile, and was sunk to a depth of 600 feet. In 1857 the first attempt was made to lay a cable telegraph line across the Atlantic ocean. This remarkable enterprise was headed by Cyrus W. Field (1819), of New York; Charles Bright, J. W. Brett and other capitalists in England. It was intended that the cable should run from Valentia, Ireland, to Newfoundland, and that its length should be 2,500 miles. After 255 miles of the line was reeled off, the cable broke, and the whole attempt was abandoned. But Field did not give up the project of a transatlantic cable. In 1858 a new cable was constructed, and the American ship Niagara and the British ship Agamemnon proceeded to lay it. The work was completely successful. The Queen of England and the President of the United States sent each other congratulatory messages over the wire, and everybody said that the greatest event of the century had happened. The cable was 2,050 nautical miles in length. After one month of use the cable ceased to work, and it was never operated afterward, nor was any part of it recovered. Altogether the first cable carried 730 messages, consisting of 10,000 words. Its cost was $1,256,250.

"In spite of the great loss of labor and capital involved in the failure of the second Atlantic cable, Mr. Field clung bravely to the hope of being able in some way to plant a submarine telegraph line that would stick. Meanwhile cables were being laid in many parts of the earth, notably that connecting England with British India through the Red sea and the Arabian sea. Its entire length was 3,043 nautical miles, with several intermediate landings. Some parts of this cable worked satisfactorily for thirty days, and then the entire line failed and was abandoned. Out of all these failures men were beginning to learn something about laying cables. The British Board of Trade appointed a committee to study up the question. This committee reported that it believed that a successful submarine telegraph line could be laid if sufficient attention were paid to the construction of the cable used. Such a cable was manufactured in 1861, and was laid across the Mediterranean sea, from Malta to Alexandria. There were seven copper wires in this cable. They were stranded together and covered with several coatings of gutta-percha. Around this cable eighteen iron wires were spirally wound to bind the cable together. This cable proved successful.

"In 1864, the Indian government undertook to connect British India with England by a cable running through the Persian gulf and the Arabian sea. This line, when laid, was completely successful, and was the first electrical communication, worthy of the name, that had been

established between India and the home country.

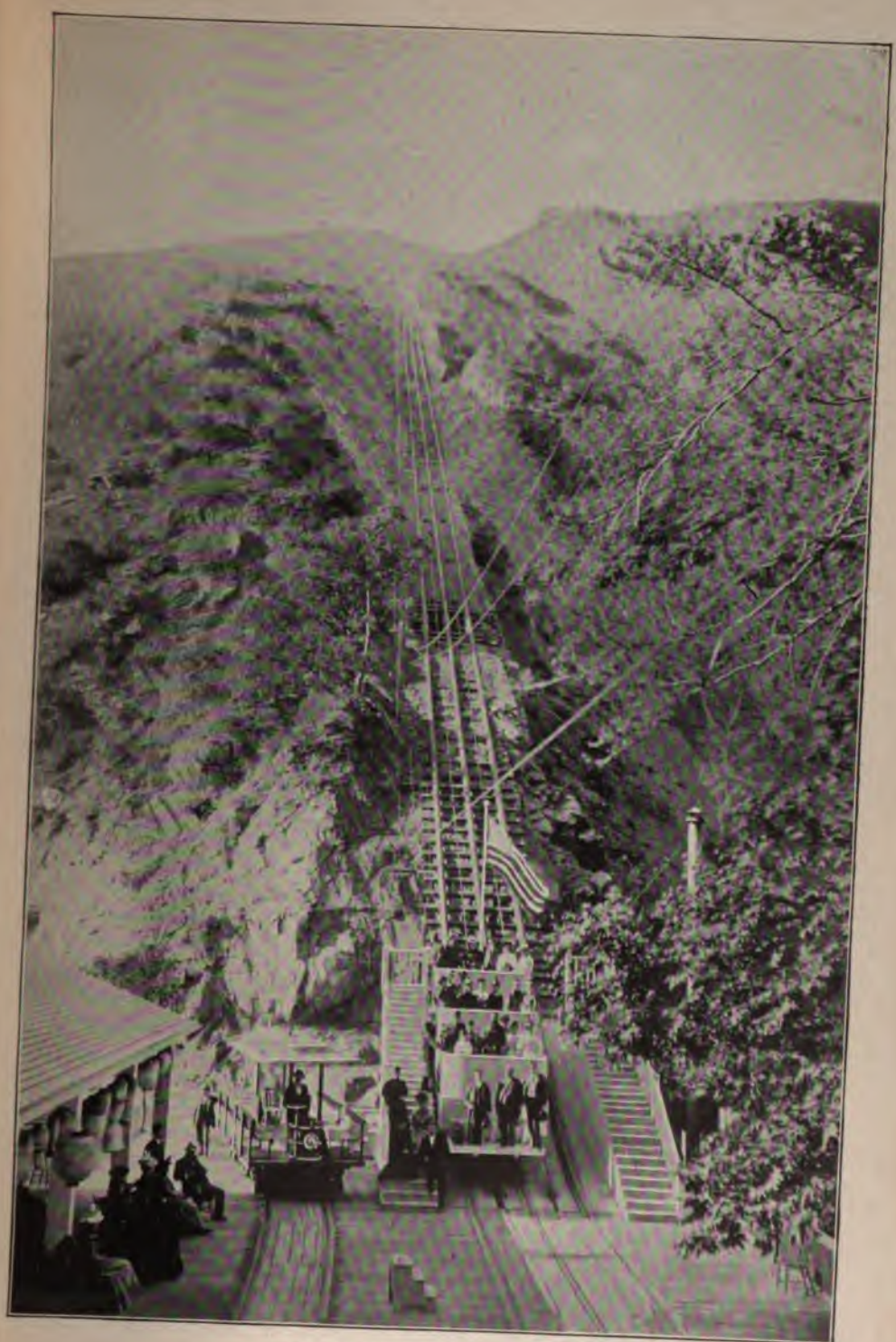
"In 1865 Cyrus W. Field made another attempt to lay an Atlantic cable. Great precaution was taken in the construction of the cable itself. It consisted of seven copper wires coated with gutta-percha This was in turn surrounded by ten Bessemer steel wires—the first time steel wires were used for cable protection. The steamer Great Eastern, then the largest boat in the world, was used to reel off the cable. It was intended to stretch the wires between Valentia, Ireland, and Newfoundland, but when 1,186 miles had been laid out the cable broke and was lost in 11,000 feet of water. It was never recovered. This experiment cost Mr. Field and his friends $3,000,000. But they were not discouraged. The very next year they built a new cable and remodeled the Great Eastern. That big boat, with the cable on board, left Valentia July 13, 1866, and arrived at Newfoundland fourteen days later with her thousands of miles of cable behind her. A few moments after the landing of the Great Eastern, electrical communication with London was set up, and has never been interrupted since."

There are now fourteen lines across the Atlantic, besides those in other oceans, nearly a hundred thousand miles of sub-marine cable, and more than a million miles of land wire, of which this country has more than any other, and the time is near when the electric throbs of communication will travel round the entire globe.

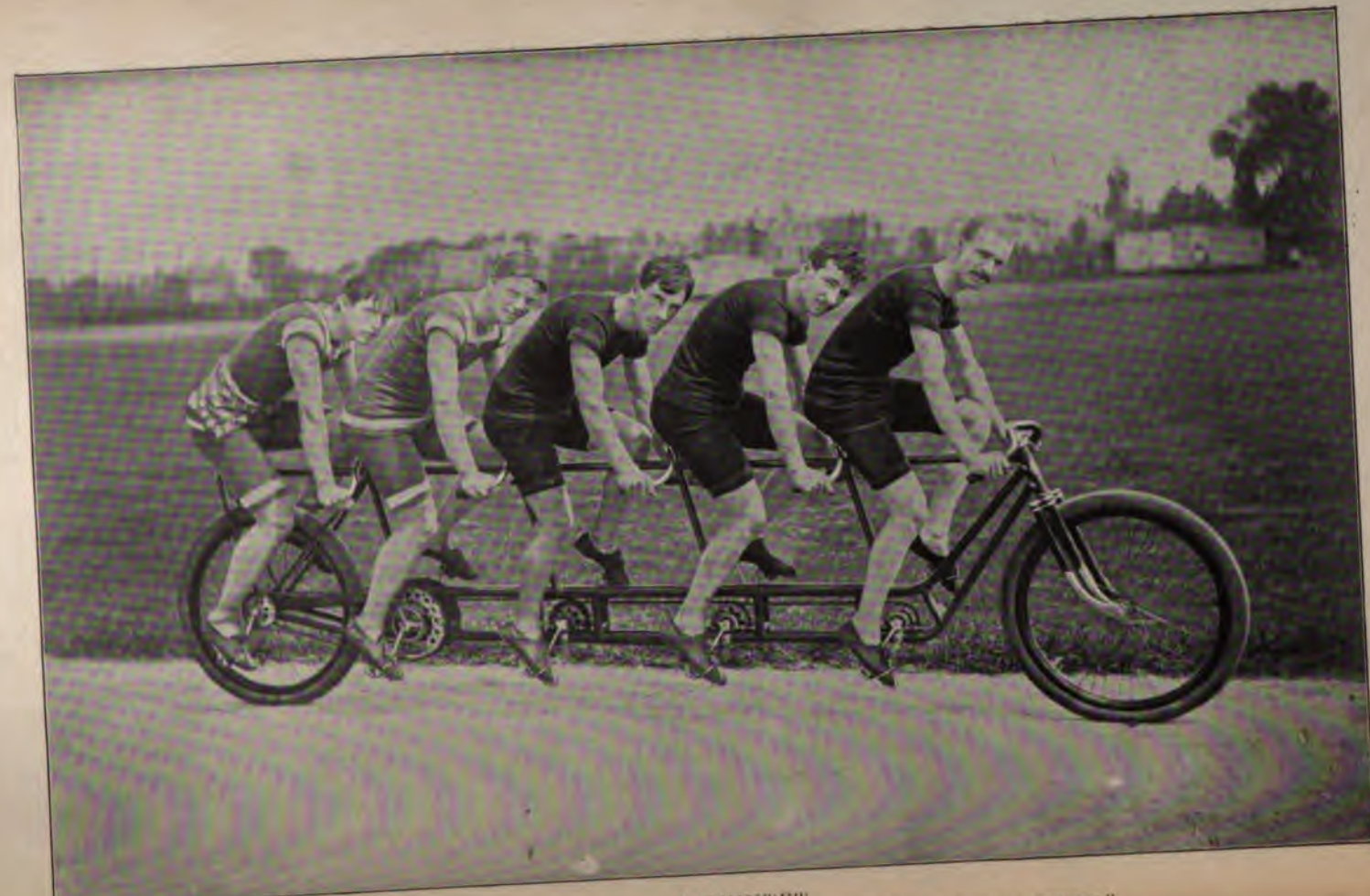
The Newfoundland superintendent of the Atlantic cable once sent a message across the Atlantic, "with a battery composed of a copper percussion cap, and a small strip of zinc, which was excited by a drop of acidulated water, the simple bulk of a tear."

The district telegraph system preceded the telephone, and was very useful. It consisted of a dial on the wall, connected by a wire with the main office. On pointing the index to "Fire," "Doctor," "Police," etc., and pulling a lever, the want was made known and answered. The burglar alarm rings an electric bell, if a door or window be moved. Annunciator bells, connected with all the rooms of a hotel, are rung by pressing a button; table bells, door bells, etc., are in general use. Patrol boxes in cities connect with the nearest police station; in fact, there are numberless contrivances, and they are constantly increasing, by which time and space are annihilated. The city fire alarm soon followed electrical invention.

A recent invention to aid telegraphy, and one also which is already in practical shape for immediate use, is the "synchronograph," the product of the combined brains of Professor Crehora, of Dartmouth college, and Lieutenant Squier of Fortress Monroe. It is a device which is also aimed to avoid the "kick" on the line when the circuit is opened or closed, and accomplishes the end by the use of an alternating current. In this machine the breaks in the circuit are timed to come exactly in the middle of the alternations, when the current is not running at all.



A MOUNTAIN RAILWAY.
"No ascent is too steep for modern railroad engineering"



A QUINTET. ...ving five or even ten persons."

Perforated tape similar to that in the typewriter is employed. In fact, the inventors expect to put an attachment on any typewriter so that it will cut out tapes at will. This curious telegraphing machine is said to have a capacity of sending 4,000 words a minute—something which leaves ordinary instruments miles behind.

Gray's Telautograph repeats and records, in perfect fac-simile, any message or design sent over the wire. It embraces two instruments, one at each end of the line, a transmitter and a receiver. Each of these is contained in a wooden case somewhat smaller than a typewriting machine. In transmitting a message, drawing, sketch, or whatever may be desired, the sender takes an ordinary lead pencil and writes or draws his message with it on a sheet of paper, and simultaneously another pencil at the receiving end of the line reproduces every movement of the sender's pencil on a similar sheet of paper. It enables communication to be made with absolute secrecy, both in sending and receiving, and it has the great merit of insuring absolute correctness in transmission, which neither the telegraph nor the telephone insures. The telautograph writes its record in black and white, and eliminates every element of uncertainty. Dr. Elisha Gray is its inventor.

The latest improvement in telegraphy was patented in 1899 by the Crehore-Squire Company (Albert E. Squire and Crehore, the former one of the inventors). It is called the sign-wave system, and sends as high as 4,000 words per minute. In 1898 it was tested by the government. Over 3,000 words were sent at that time. The receiving instrument prints the message out on paper.

THE TELEPHONE.—The first suggestion of the telephone was made in 1837 by Professor Charles G. Page, of Washington, who discovered that the rapid magnetization and demagnetization of a magnetic bar would make sounds, but nothing practical resulted until in 1854, when Charles Bourseul, a Frenchman, declared that it was possible to send speech by electricity. He said: "We know that sounds are made by vibrations, and are adapted to the ear by the same vibrations which are reproduced by the intervening medium. But the intensity of the vibrations diminishes very rapidly with the distance, so that it is, even with the aid of speaking tubes and trumpets, impossible to exceed somewhat narrow limits. Suppose that a man speaks near a movable disk, sufficiently flexible to lose none of the vibrations of the voice, that this disk alternately makes and breaks the current from a battery; you may have at a distance another disk, which will simultaneously execute the same vibrations. It is true that the intensity of the sounds produced will be variable at the point of departure, at which the disk vibrates by means of the voice, and constant at the point of arrival, which it vibrates by means of electricity; but it has been shown that this does not change the sounds. It is, moreover, evident that the sounds will be produced at the same pitch. . . . Ob-

serve that the syllables can only reproduce on the sense of hearing the vibrations of the intervening medium, reproduce precisely these syllables. It is, at all events, impossible, in the present conditions of science, to prove the impossibility of transmitting sound by electricity. Everything tends to prove, on the contrary, that there is such a possibility—however this may be, it is certain that, in a more or less distant future, speech will be transmitted by electricity."

This declaration was made less than fifty years ago, and only about twenty years were to pass before the prophecy should be fulfilled, for on the 14th of February, 1876, Elisha Gray and Alexander Graham Bell deposited in the patent office, in Washington, applications for patents for instruments of the same kind. There has been a great controversy over the rival claims of Gray and Bell, but it has been usually decided that Bell was the inventor, though it had been suggested by Bourseul, in 1854, and in 1851 Bushman, in Racine, Wisconsin, had actually sent telephonic messages.

At first the telephone was very indistinct, but with later improvements the Bell-Edison telephone transmits the human voice distinctly for very long distances. Improvements by Blake, Berliner and others have been added, men who should be ranked among the benefactors of the century.

Professor A. Graham Bell was born in Edinburgh, Scotland, 1847, and was educated at the Edinburgh high school and Edinburgh University. In 1872 he took up his residence in the United States, introducing with success his father's system of deaf-mute instruction and becoming professor of vocal physiology in the Boston University. He had been interested for many years in the transmission of sound by electricity, and had devised many forms of apparatus for the purpose, but his first public exhibition of the telephone was in Philadelphia in 1876, and the photophone in 1880. Its complete success has made him wealthy.

Elisha Gray was born in Barnesville, Ohio, 1835. His first invention was the needle annunciator for hotels, invented in 1870, and perfected in 1872. This was followed by the electrical annunciator for elevators, and later by the private telegraph line printer. From 1873 to 1875 his attention was largely absorbed in developing a system of electro-harmonic telegraphy for the transmission of sounds over telegraph wires. On February 14, 1876, he filed at Washington a caveat for "Art of transmitting vocal sounds telegraphically." But Professor A. Graham Bell, though probably anticipated in point of time by the caveat of Professor Gray, was granted a broad patent for speaking telephones March 8, 1876, and sixteen years of litigation failed to deprive him of the credit as the inventor. Professor Gray's latest invention is the telautograph, for the transmission of written language in fac-simile. Besides the electric needle annunciator for hotels, he has invented the telegraphic switch. Later he invented

the dial telegraph, an instrument in which a pointer ran from letter to letter, stopping long enough for the letter to be noted and recorded. This was soon superseded by a telegraph instrument which printed the message. This was in extensive use in all of the large cities of the United States when the telephone was developed. It yet survives in the familiar "tape machine" and "ticker," and has developed into a variety of improved forms of printing by wire and electricity.

Wheatstone, in England, had observed that electric wires carried noises curiously. In 1841 John Taylor, an English captain, invented an instrument that he called a telephone, that conveyed sounds at sea through trumpets, by means of compressed air. But the germ of the telephone comes from Reis, a German professor, who, in 1860, with a coil of wire, a knitting needle, the skin of a sausage, the bung of a beer barrel and a strip of platinum, reproduced the sound of the voice, and communicated it along a wire. In 1868 Daniel Drawbaugh, in Pennsylvania, claimed to have made a successful telephone, and he has contested the Bell monopoly, but in vain. The courts have decided in favor of Bell, though Bell and Gray filed their caveats the same day.

Professor Bell invented the telephone when making efforts to soften the misfortunes of his deaf and dumb wife, whom he married in 1876. Bell's income from his great invention is said to be $1,000,000 a year. Bell says: "It is what has been called the cross-fertilization of the sciences: two ideas pursued on independent lines of investigation were made to correlate, and the result was the telephone."

Thomas A. Edison, the modern wizard among inventors, was born in Milan, Ohio, February 11, 1847. He began life as a train boy, at twelve. He was fascinated as a boy by the telegraph, and learned telegraphy from a man, the life of whose child he had saved. He studied the science continually until he produced sextuplex telegraphy, the microtasimeter, the phonograph, the aerophone, the megaphone, the microphone, the phonometer, the kinetograph, the kinetoscope, the electric pen, the incandescent light, etc. The poor boy, owing nothing to schools, parentage, education, patronage, society, or environment, had risen to the position of the century's greatest benefactor, before attaining the age of forty, and is certainly one of the greatest geniuses of all the ages. He was a seller of newspapers in his teens, and a reader, even then, of Newton's "Principia" and Dr. Ure's Dictionary, a telegraphic operator—an experimenter with telegraphic wires, until he invented, among others, the following: (1) The duplex telegraph, by which his messages can be sent in opposite directions over the same wire without confusion. (2-6) Quadruple autographic, harmonic, multiplex, automatic and phonoplex telegraphs. (7) Telegraphing from a moving train without the use of a special wire between or along the tracks, sometimes called the "grasshopper telegraph," in the invention of which Mr. Edi-

son was assisted by W. Wiley Smith. (8) The carbon rheostat. (9) The pressure or carbon relay. (10) The Edison dynamos, which were the first made with massive field magnets. (11) The pyro-magnetic motor. (12) The pyro-magnetic generator, which is used in the production of electricity direct from coal. (13) The tasimeter, which is used for detecting small variations in temperature. (14) The odoroscope, somewhat similar to the last. (15) The Edison microphone. (16) The incandescent lamp, which, with the exception of the phonograph, is the most widely known of his inventions. (17) The Edison meter, which registers correctly the quantity of current supplied to each consumer of electric light. (18) The weight volt-meter, another improvement for measuring electric light currents. (19) The Edison electric pen. (20) The Edison mimeograph, used for manifolding manuscript. (21) The Edison vote-recorder, by which a member of a legislative body can, without leaving his desk, instantly record his "yea" or "nay" vote at the speaker's desk. (22) The magnetic ore-separator. (23) The magnetic bridge, which enables accurate tests of the magnetic properties of iron used for dynamos and motors to be made. (24) The dead-beat galvanometer, which has neither coils nor magnetic needles. (25) The phonometer, or vocal engine, which develops to a considerable degree the vibrations produced by the human voice. (26) The Edison-Sims torpedo, a submarine torpedo boat, operated by electricity, in the invention of which Mr. Scott Sims had a hand. (27) The phonograph. (28) Telephone transmitters. (29) The electro-motograph. (30) The motograph receiver, a modification of the telephone transmitter, which reproduces the voice with great strength and clearness. (31) The telephonograph, which obtains and reproduces messages spoken from a distance. (32) The megaphone, a simple device for carrying on conversation between persons separated at a distance of two miles or over.

The most popular of his recent inventions are the kinetograph and the kinetoscope. The former is a device for taking a series of photographs of a moving object at the rate of about thirty a second. The latter is an instrument for exhibiting them. There are many improved forms of the kinetoscope, but the methods used are practically the same. By means of the magic lantern, the pictures are thrown upon a screen, reproducing the motions of the original upon a large scale. (See "Photography.")

The wizard relates the circumstances of the invention of the phonograph: "I was singing to the mouthpiece of a telephone, when the vibrations of the wire sent the fine steel point into my finger. That set me to thinking. If I could record the action of the point, and then send the point over the same surface afterward, I saw no reason why the thing would not talk. I tried the experiment, first on a strip of telegraph paper, and found that the point made an alphabet. I shouted the word 'Halloo! Halloo!' into the

mouthpiece, ran the paper back over the steel point, and heard a faint 'Halloo! Halloo!' in return. That's the whole story. The discovery came through the pricking of a finger."

Many of Edison's inventions have been side-tracked by him, because of their lack of practicability. For instance, he recently has succeeded in utilizing X-rays for the manufacture of a phosphorescent lamp, which would revolutionize the entire problem of artificial light if the question of cost could be solved. "We may get that by and by," he says, "but it doesn't seem to be within reach now." And so the cumbersome and complicated experimental machinery employed to produce the new light has been temporarily laid aside. For many years he has been trying to derive electricity directly from coal, and although he has produced some satisfactory results the question of cost thus far has proved prohibitory.

The polyphone, the gramophone and other instruments are employed to reproduce songs, speeches, etc., and the "Wonderful Banjo" surpasses any hand-played instrument in the power and excellence of its execution. (See "Music.")

Many of Edison's discoveries are practical improvements of what others have conceived. He seems to see nothing in which he cannot suggest improvement. His electric light is a practical thing that others had invented. As early as 1849 Despretz, the French scientist, described a series of experiments with carbon sticks sealed in glass globes, from which air had been excluded. After him, Farmer, Draper, Henry, Morse and Maxim experimented in the same direction. But the discovery was a laboratory curiosity until Edison began with it. The light only lasted for a short time, and was too expensive for use. He substituted carbonized paper for platinum. After repeated experiments, with insurpassable patience, he found that a species of bamboo answered his purpose best. The lamp did not burn because air remained in the glass bulbs. He invented air pumps by which air down to one-millionth part was excluded. Then, as copper wires were too expensive, and used up steam power too fast, he devised new conductors and generators, and after incredible labors he gave the electric light to the world. He has been no less successful in improving the telegraph, telephone, electric railway, dynamo, electric pen, ore-extracting machines and other inventions.

Edison does not agree with those who think that future centuries can never equal ours. He says: "We ought to be ashamed to think that invention has been exhausted with the telegraph, telephone, steam engine, dynamo and camera. The next century should go as far beyond 1900 as 1900 is in advance of 1800."

The electric pen, invented by Edison, consists of a handle carrying an electric-motor, actuating a needle, which is driven in and out of the other end of the handle with high rapidity. It is used by being held vertically on the paper with the

needle end downward, and is moved so as to describe perforated letters or designs. The paper is then used as a stencil, with an ink-roller to produce the writing or design *ad libitum*. In perfecting the telephone, Edison spent a great deal of time and money in trying nearly every known substance which might possibly be utilized for the transmission of sound. He resides in Menlo Park, New Jersey. From his workshop there he is continually startling the world by his wonderful discoveries. The telephone can be used, so that messages can be understood at a distance of a thousand miles or more, as if the parties were in the same room, recalling the imaginary wonders of the Arabian Nights. Merchants and traders would be loath to part with the instrument as a necessity of business. The telephone was an outcome of the telegraphic system, and there are now nearly 675,000 instruments in the hands of licensees of the American Bell Company, and over 750,000,000 exchange connections in a year in the United States.

On the 6th of November, 1897, Helen Buckley sang, in Chicago, and the sounds sped eastward on the long distance telephone and, crossing Indiana, Ohio, Pennsylvania, and New Jersey, they plunged under the Hudson and set the receivers vibrating up in the twelfth story of the Telephone building, a thousand miles from where they started.

The wires centered in a large desk, on which lay a score or more receivers for the guests. When all was ready the operator called up the long distance department and asked for Chicago. The connection was made, and the receivers were handed to those present.

"All ready here," said Chicago. Every word was distinct.

"All right," said the operator, "go ahead."

There was silence for a minute, and then a piano was heard. After a few bars the voice of a woman rose clear, sweet and strong in Mendelssohn's "Hear Ye, Israel," from the oratorio of "Elijah." It seemed as if she was singing in a room near by. The song ended with a full, clear note and crashing peal from the piano, and the listeners dropped the receivers to applaud. Hardly a break marred the beauty of the voice, and even the softer passages were pure and distinct.

Nikola Tesla was born in Servia, and came to this country to work in one of Edison's shops. He showed a marvelous inventive genius in the realm of electricity, and his discoveries have astonished the world and shown that he is only second to the great Edison.

Perhaps the most incredible invention, *a priori*, is the phonograph. In 1856 Leo Scott invented what he called the phonautograph which recorded the human voice indistinctly but not intelligibly, but Edison's phonograph repeats audibly and intelligibly the very language it records in the exact tones in which it was uttered. A light spiral groove is cut in a cylinder, over the surface of which is placed a sheet of tinfoil. A mouthpiece, like that of the telephone, has a vibrating membrane,

on the other side of which is a metallic point which touches the tinfoil above the spiral groove. A crank revolves the cylinder as the voice is spoken into the mouthpiece. The metallic point marks the vibrations, and when the speaking is finished the point is set back to the starting point. Then, by turning the screw as before, the point will follow the track made by it, and produce the same vibrations, and repeat the exact sounds and words. If the cylinder is taken out and laid away it can be used at any time, and the song, oration, or other language can be repeated and reheard.

The author of this volume has listened to the ravings of John McCollough, in his madness, the famous "cross of gold" speech of W. J. Bryan, and all kinds of utterances are heard in public exhibitions of this wonderful machine. Sentences can be recorded, one above another, so that different languages may be heard simultaneously, or a speech, a song and a poem at the same time. Edison exhibited this remarkable invention in Paris, in 1878, before the French Academy of Sciences.

When his agent, Mr. Puskas, caused the wonderful instrument to speak, a murmur of admiration was heard from all parts of the hall—a murmur succeeded by repeated applause. A letter appeared in the newspapers from one of the persons present, in which he said that the learned academy, generally so cold, had never before abandoned itself to such enthusiasm. Yet some members of a skeptical turn of mind. instead of examining the physical fact, ascribed it to moral causes, and a report soon ran through the room which seemed to accuse the academy of having been mystified by a clever ventriloquist. Certainly the spirit of ancient Gaul is still to be found among the French, and even in the academy. One said that the sounds emitted by the instrument were precisely those of a ventriloquist. Another asked if the movements of Puskas' face and lips, as he turned the instrument, did not resemble the grimaces of a ventriloquist? A third admitted that the phonograph might emit sounds, but believed that it was much helped by the manipulator. Finally the academy requested Du Moncel to try the experiment, and as he was not accustomed to speak into the instrument, it was unsuccessful, to the great joy of the incredulous. Some members of the academy, however, desirous of ascertaining the real nature of the effects, begged Puskas to repeat the experiments in the secretary's office under such conditions as they should lay down. The agent complied with the request, and they were absolutely satisfied with the result. Yet others remained incredulous, and it was necessary that they should make the experiment for themselves before they accepted the fact that speech could be reproduced in so simple a way."

Edison has also a practical telegraphing device in use for some time on several railroads in this country. It permits signaling to and from trains in full motion. It has already saved several wrecks, caught criminals, and performed other feats of

value to society. Lucius J. Phelps is also author of a train telegraph.

An ordinary battery, a couple of telephone receivers, and induction coil with vibrator, and a Morse key constitute the detail of the apparatus. The roofs of the cars are rendered available by the detachment of wires connected with one another and with the instruments. These in turn are linked with the earth through the car wheels and track. There is little difficulty in making the message jump the necessary 500 feet, the distance between the cars and the overhead wires.

THE ELECTRIC LIGHT.—Picture the lack of comfort which a hundred years ago was the universal lot of human homes, in the mere matter of artificial light. How were they lighted? The mansions of the rich by candles of wax or dimly burning lamps of ill-smelling whale oil. The houses of others, even of the well-to-do with oil or tallow candles, which scarcely did more than make "darkness visible," except for a foot or two round each feeble flame. The great masses of the people knew no better light than "tallow dips," made by repeated insertions of cotton wicks in melted tallow. Street lights were produced by whale oil, and lighted by the professional lamplighter, who, with torch and ladder, went from post to post and kindled the smoking attempts to disperse the universal gloom. Truly it was a dark world in which those lived who boasted of the wonderful era in which they began the century in the course of which mankind was to make such strides of progress.

COOKING BY ELECTRICITY.

What the tallow-dip and obscure

compound of stench, vapor and light that emanated from candles and whale oil are to gas or the incandescent electric light, that were the comforts and conveniences of human homes then to the advanced improvements and enjoyments of domestic and social life in the year 1900.

Until the electric light was invented, there was no adequate illumination. There was no such thing as efficient street-lighting; the comparatively insignificant jets of light in the light-house did not at all answer the end which they should. The world was too dependent on the moon and stars at night; we were left at the mercy of expensive, and oftentimes, offensive gas; the sleeping rooms are yet too often redolent of the stifling vapors of kerosene, the great cities are full of ambuscades, hollowed out in the darkness, in which assassination lurks and the robber awaits his victim. The intellectual brightness of the age had found no corresponding illumination of terrestrial night until the electric light came, the representative of the age in which it was discovered. About 1860 it was first used for light-house illumination. In 1877 it was first employed for street-lighting. The streets of New York were first lighted by gas in 1824-25. Before that whale oil lamps were used. In fifty years the home light has evolved from the tallow-dip through the mould-tallow, the sperm candle, the whale oil, camphene, mineral oil, kerosene lamps and gas, until now the incandescent wire is in use.

When tallow, wax, whale oil, lard oil, camphene, kerosene and gasoline had been superseded by coal gas as the means of producing artificial light, it was thought by the great majority of people that the *ultima thule* of improvement in that direction had been reached. But inventors were dreaming of something better, and repeated but unsuccessful attempts had been made to develop a better light than gas-light. The best electric light is now produced by the white-hot points of two pieces of carbon employed as electrodes, or by the incandescence of a wire or carbon filament in an electric current.

In 1809 Sir Humphry Davy discovered the phenomenon of the voltaic arc. He used as electrodes points of charcoal. Foucault, Jablochkoff, and later experimenters, replaced these by pencils of gas-retort carbon, and this material is yet used in some forms of regulators. A better result, however, is obtained from manufactured carbon pencils, and this manufacture already represents a distinct trade, both here and in Europe. Coke, lamp-black, cane-sugar, etc., are the ingredients used for these pencils, which are subsequently placed in moulds and submitted to a red heat. Davy's suggestive experiments were of mere scientific interest until the improved battery-cells, invented by Grove and Bunsen, came into use forty years later, when many attempts were made to turn the electric-light to practical account; but owing to the trouble, expense, and other difficulties attendant upon the use of a battery, the light was still only

available for exceptional uses. The discovery by Faraday (1830) that an electric current could be induced in a coil of wire by the approach to it or recession from it of a magnet, may be said to have given electricians the first hope of giving the electric light a commercial importance. The magneto-electric machines which followed upon Faraday's discovery were soon many in number, each one exhibiting some improvement over its predecessor. Of these pioneer machines may be mentioned that of Ritchie (1832), who caused a horseshoe magnet to turn beneath bobbins of wire suspended above its poles. Clarke's machine, where the reverse method was adopted, the bobbins moving near the poles of a fixed magnet. Siemens, who, in [illegible] introduced a new form of armature [illegible] coil, which superseded the [illegible] formerly used; Wilde, of [illegible] who produced a power[illegible] in which the electro[illegible] first employed in this [illegible] being excited by a [illegible] ordinary horseshoe [illegible] In 1845, King, in England, [illegible] light in which an electric [illegible] a piece of platinum [illegible] In 1849, Petrie im[illegible] invention by using irid[illegible] of platinum. In 1866, [illegible] and also Wheatstone, [illegible] that this initial excita[illegible] unnecessary, because the [illegible] of the electro-magnet al[illegible] a certain amount of [illegible]ism, which, by proper [illegible] could be roused into [illegible] effects. Holmes, [illegible] also produced machines worthy of mention. A machine, called the "Alliance," was fixed at the South Foreland Lighthouse in 1872, and is still in use there. It was invented by Professor Nollet, of Brussels, in 1849, and was used for the service of some French light-houses before it was employed in England. It is of a most cumbrous nature, and in common with the machines already noticed, must be considered obsolete. In 1872, Gramme (France) gave the subject of electric illumination fresh impetus by the introduction of a small and compact machine, which altogether distanced its prototypes in power and efficiency, and we may date from this time the excitement which has been growing of late years concerning the electric light. In 1873, Lodyguine, a Russian, substituted carbon. In England the Gramme machine was first used in 1874, to provide a light for the summit of the Westminster clock tower. Since that date it has been greatly improved. The Gramme machine gives a continuous current like that afforded by a voltaic battery; but previous machines, like the "Alliance," for instance, gave an alternate current, which had for most uses to be turned into one direction by a device called a commutator, which formed an attachment to such machines. In France the Gramme machine is used almost exclusively, not only for lighting, but for electroplating and electrotyping. In 1875, Kohn suggested two carbons, side by side. Edison experimented with every substance which bore the name of carbon, or

l be carbonized, and explored
ıemispheres, before he hit upon
ɔamboo, which would yield just
brous structure that he wanted,
thus produced the cheap, con-
ɜnt and apparently perfect elec-
ights now in general use. It
s impossible to go beyond the
son" or "Brush," but the word
ssible, applied to inventions or
ɔvements seems well-nigh obso-
The principal lamps for the
ɔf the arc light are the Brush,
the first successful one, in-
d by Charles F. Brush, Rapief,
ermann, Wallace, and Jab-
off. Not only for house and
lighting, but for many other
ɔses the electric light is invalu-
Minute ones are used to
ine throat and stomach and
internal organs.
1802, Davy made carbon points
electric lights. In 1834 Lind-
799) produced an electric light.
ott, in 1844, by a different pro-
accomplished the same result.
early as 1841, a platinum wire,
incandescent with a battery
nt, was proposed as a source of
and in 1845 slender rods of
n were used by King and J.
arr in this country. Next year
ıer and Staite, and in 1849
e experimented, but it was in
that Lodyguine, a Russian,
ted a carbon incandescent lamp.
as but partially successful,
gh improved by Kohn, Reynier,
ve and others. Edison, in 1878,
a wire of an alloy of platinum
iridium, and after many experi-
s, he made carbon filament of
ɔoo, and in 1880 he perfected the
incandescent lamp. About the same time J. W. Swan, in England, exhibited incandescent lamps, and the two patents are now combined. An ingenious adaptation of the light is the portable one for miners. It has a four-celled accumulator, and is safe because the circuit is interrupted if the glass case is broken.

The Gramme machine, for producing electric lighting and power, was first made in 1870. This light had been used in light-houses as early as 1862, invented that year by Holmes, and used in the South Foreland light-house, England. A light was produced in France in 1855, by electricity. It was suggested by a Belgian scientist in 1849. Wilde, Ladd, and others produced light by electricity. But Siemens improved on the Gramme principle, and produced what he called a dynamo-electric machine, and originated the term dynamo. Since then dynamos have been produced by Brush, Servin, Thomson, Houston, Edison, etc. In 1878, Jablochkoff orginated the electric candle, which, for the first time, demonstrated the practical utility of electric lighting.

Charles F. Brush (1849) began in 1875 to study improvements on the Gramme or Siemens dynamo, and in a short time produced a superior dynamo, and then the famous Brush arc light, now in use all over the country. Mr. Brush has taken out a large number of patents, most of which yield him a revenue.

The electric candle is a modification of the arc form of electric light, in which the carbon pencils are parallel and separated by a layer of

plaster of Paris. Invented in 1877 by Jablochkoff, a Russian engineer. The invention is noteworthy as having revived an interest in electric illumination.

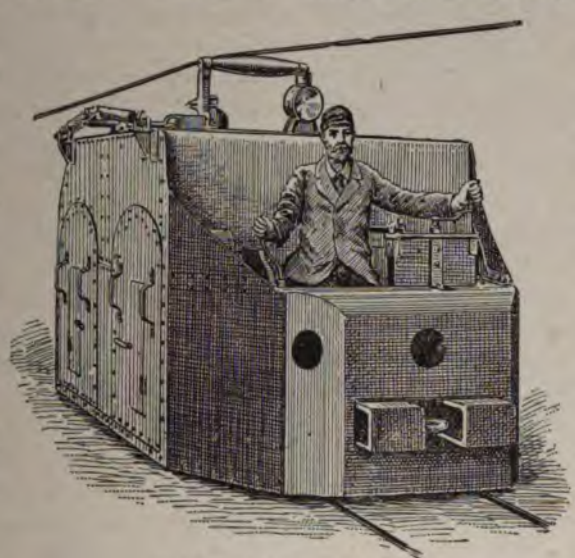
The electric lamp is a contrivance for holding in position and regulating the movements of the carbon electrodes, between which the arc light is produced. The patent office teems with specifications of different patterns of regulators. Among the first devised were those of Duboscq, Foucault, and Serrin, the last being of very perfect form. Of later years the lamps of Siemens, Charles Francis Brush (1849), Pilsen, Crompton, and others have supplanted the older forms.

Incandescent: In this form of lamp a slender thread of carbon (carbonized paper, fiber, etc.) is enclosed in a glass bulb, exhausted of air. The passage of the electric current renders this thread white-hot. Edison, Swan, Maxim, and others have produced lamps on this principle which differ little from one another. E. A. King, in 1845, patented an incandescent lamp. The following year Greener and Staite improved upon it. In 1871, Lodyguine, at St. Petersburg exhibited 200 such lamps on one circuit. In the patent office of the United States the Edison patents on an incandescent lamp seem to stand as the fundamental ones, the principle calling forth this decision being the vacuum in which the carbon is suspended. Mr. Edison, however, made his vacuum lamp just in time to secure the co-operation of the dynamo electric machine invented two years before, without which the lamp would have been of no practical value, since the electric current cannot be made commercially in any other way. Professor Moses G. Farmer, of Boston, lighted his house with a number of platinum filament incandescent lamps in 1847, but as a curiosity only, as the generation of the required current by means of primary batteries was too costly for commercial purposes. The great litigation of the past few years over the patents on the carbon-vacuum lamp have led inventors to seek avoidance of that principle. The nearest they have come to their desire is the substitution of nitrogen, or some other gas in which combustion will not take place, for the vacuum.

Three great advances in lighting have been made: the invention of the Argand burner and chimney; gas; and electric lighting. These are distinct steps of progress, during the century, from the crude methods of all preceding time. The electric anemometer, which indicates and registers the direction and velocity of the wind, was invented by J. E. H. Gordon. The revolution in the lighting of streets, homes, business places, mines, where it is absolutely safe, in surgical operations, and manifold ways that cannot here be specified, is one of the greatest ever accomplished. Its edict in reference to any realm is like the voice of inspiration descriptive of Heaven: "There shall be no night there."

Various processes of producing electricity for practical purposes have been devised, but whether by

revolving motion, or zinc, copper and sulphuric acid, or other combinations, in jars, or by heat and cold connected with a circuit of two metals, all are the invention of a few recent years. The most successful process, until lately, has been by the steam-engine, which drives the magneto-electric machine, or the dynamo-electric machine, which produces the light or the force that impels the machine, railway car or carriage. But more recently the force of water has come to the front, and great power is generated, so that any natural or artificial waterfall may manufacture power that will by means of a wire operate at great distances. In fact, the force of rivers, the rise and fall of the tides, the action of the sea-waves, and other natural sources of power, will in time be thus utilized and transmitted where required. The transmission of power by electricity, a problem which has exercised the minds of electrical engineers for years, has been solved in one way, among others, by the transmission of 10,000 volts from a waterfall twenty-eight miles distant, by which the cities of Pomona and San Bernardino, California, are lighted in a very satisfactory manner. Niagara alone could yield electric force sufficient to perform all the labor of this country, and the rivers, streams and tides are equal to producing all the motive power and lighting required, should the population increase a hundred fold.



TROLLEY CAR USED IN MINES.

Professor Blyth, as long ago as 1872, ventured to say that magneto-electric machines might be employed to utilize the water-power, at present running to waste, of mountain torrents, by first employing these torrents to generate current electricity by means of magneto-electric machines, and then transmitting the currents by means of wires to drive an electro-magnetic machine wherever wanted. This dream has been more than realized. Already the graceful Undine, dancing down the precipitous canyon, generates the force that sheds the radiance of a light far out on the sea, or industriously drives the useful machine. And it has already been demonstrated that every cascade and waterfall, nay, every returning wave of the sea, is stored with electric energy

that is accessible to man, and that may be harnessed to his industries. Niagara Falls alone are capable of lighting every city in the land, and moving all their machinery. It was only this century that arrested the idleness of the great cataract, and set it to work for mankind.

One of the latest achievements is the "storage battery," by means of which electric force can be bottled, so to speak, and accompany car or carriage. Already electric road carriages are not uncommonly seen in the streets of cities, and the overhead and underground trolleys are dispensed with, and each street railway car carries its own motive power. In 1834, Faraday demonstrated that chemical and electrical energy are convertible. In 1839 Plante produced the cell, and in 1860 perfected it. In 1879 Brush, and in 1880 Camille A. Faure, and subsequently Swan, Sellon, Volckmar, Shaw and others improved on the Plante cell, until the storage battery seems perfected. Soon it may be that small reservoirs of electricity will be transferred from factory to dwelling, and be made available for domestic purposes and uses—the house lighted, the door bell rung, the sewing machine run, etc. It is only a matter of a very short time. Already cabs and other carriages are being moved by electricity, and it is safe to predict that ere the twentieth century is far advanced, the constantly cheapening processes of generating electric force, and the frequent improvements introduced will depose the horse, man's noble companion for centuries, from the position he has so long occupied, and he will become only the occasional, as he has heretofore been the constant, servant of man's convenience and comfort.

Tesla says: "At Niagara it may be possible to generate electrical energy that can be used to drive mills in New England, railroad trains across the prairies, and steamships across the sea."

Of Marconi and his attempt to telegraph through the air from the Eiffel Tower in Paris to St. Paul's Cathedral in London everybody is now talking. By means of making a spark in a large coil he sends out electric rays or vibrators, which will traverse any known substance, and can be picked by a suitable receiver long distances away. Marconi has found that the distance which he can send these undulations depends on the height of the wires up into the air at the sending and receiving stations. Using the top of the Eiffel Tower and a kite flown from the top of St. Paul's, he thinks he can telegraph across the English channel. There are many startling developments possible from this idea. Ships may be directed, warned, or possibly even blown up at sea by this mysterious vibration force. Armies may be kept in touch with their commanders, or with each other. Forts and mines may be destroyed. Altogether, the possibilities which this new vibration holds out are far-reaching and almost incredible, so says a recent Chicago "Sunday Tribune."

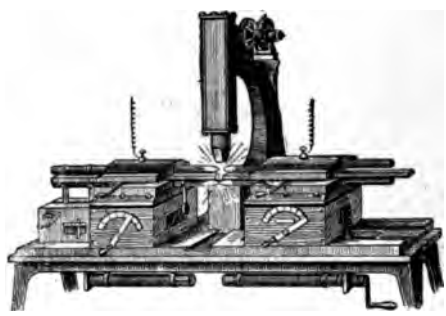
Just as this volume goes to press Tesla announces an invention based on Marconi's discovery, which, if it

shall fulfill his program, will be one of the most astonishing achievements of inventive genius. The disarmament of the nations of the world ceases to be a probability, and becomes a necessity as a result of the combined discovery and invention. After having demonstrated that messages could be transmitted on electrical currents with no other carrying medium than the atmosphere, the idea occurred to him that he could bring these currents under absolute control. This he claims to have accomplished by years of persistent effort, so that he is now able to bring electrical currents to bear upon an object and subject it to the control of his will. Without the aid of wire or any intermediate mechanical connection, he can direct the electric current against a vessel equipped with receiving plates in a way to govern its movements as completely as if it were under the guidance of a skilled navigator and manned by a competent crew. The actual employment of Tesla's invention and discovery would mean the annihilation of navies, and, as it can be employed with comparatively deadly effect on land, it would mean the annihilation of armies—and the end of war.

But it is not as the discoverer and inventor of methods and devices for human destruction that Tesla desires to be known, but as the man who makes it possible, by the control of that most subtle fluid and mysterious force called electricity, for the world to enjoy universal peace.

At a convention of street railway men, held as late as 1887, a discussion of electric traction, as applied to horse railways, was vigorously criticised as a waste of time, which could be ill-spared for the consideration of such fanciful or theoretical subjects. It was contended that the care and feeding of horses could much more profitably occupy the attention of the convention than such an unimportant question as electricity, from the point of view of car propulsion. Yet, in five years from that time the horse, as a factor in car traction, was practically shelved. In 1887, there were, perhaps, not more than twenty trolley cars in actual service, and the success of even these was by no means assured. In 1897 there were 37,000, and to-day electric traction is generally regarded as the ideal method for elevated railways, and as practically indispensible to underground or tunnel traffic in cities. Single cars are now propelled at a speed of over sixty miles an hour with safety, and locomotives run by electricity can more than equal in power those worked by steam. Within a few years, a 200-horse-power dynamo was looked upon as something extraordinary; now 2,000 horse-power machines are common, and at Niagara, dynamos are in use of 5,000 horse-power capacity, any one of which would supply more than 50,000 ordinary incandescent lights, or propel 500 trolley cars. The growth of the electrical field has been enormous; a capital of $500,000,000 is invested in electric-light supply stations and isolated plants in this country. The scope of electrical application has correspondingly widened. Many central sta-

tions not only light the streets and houses of a city with arc and incandescent lamps, but carry a large load in electric motors for running elevators, ventilating, pumping, and driving machinery. The same mains supply current for charging storage batteries, for welding metals, for cooking, for heating houses, and for the manifold purposes of the physician. The electric furnace now produces carborundum, an abrasive of such hardness that it will scratch a diamond, and the metal aluminum, which, not long ago, cost $2 an ounce, is now made electrically at Niagara, bulk for bulk, cheaper than brass. It is safe to say that a current can now be transmitted commercially to a distance of 100 miles from the point of generation, and the limits of long-distance telephone transmission are not yet reached. The closing year of the last decade affords a brilliant record in electrical work; it has been distinguished by great developments of the X ray, and phosphorescent lighting; Hertz-waves, vibrating millions of times a second, have been utilized to transmit signals to distances without wires, and the problem of deriving electricity direct from carbon, the despair of half a century of electricians, has been solved.



ELECTRIC ANNEALING.

The multiple-unit system seems destined to supersede, for many purposes, every other method of electric traction known to-day. This system is so flexible and responsive that a whole train can be operated from any car of the train, and a mere novice can handle it. A pre-eminent advantage of the system is its wonderful facility of "acceleration." This question of acceleration is now uppermost in the thoughts of all railway men. It may mean to a railroad the difference between profit and loss. On suburban service or any service requiring frequent stops at short intervals, the more quickly the normal speed of the car can be reached after the start, the less will be the cost of operation, other things being equal. It was a revelation to every engineer in the country when, recently, an eighty-ton electric train, in twenty seconds from the time of starting, was brought up to a speed of forty miles an hour. The shortening of schedule time which such a system renders possible, is of vastly more importance than any possible saving in power. The quicker the acceleration, the less is the maximum speed required for any given schedule, and the amount thrown away in braking. Chicago is leading the way in the adoption of this remarkable system, which must soon be recognized as the ideal service for elevated railways, all of which are turning to electricity as a motive power, not less than for underground

roads, which are the natural and admirable remedy for the congested suburban traffic of great cities.

The use of electricity as a motive power is rapidly supplanting steam. Says the "Review of Reviews," December, 1893: "It is now but a question of time when the mantle of the steam locomotive will fall on the electric car. The latter has made the first advances toward supplanting steam in such work as is required in the B. & O. tunnel under the city of Baltimore, where whole trains, with their locomotives attached, are hauled six or seven miles by powerful electric-motors."

Professor Joseph Henry constructed the first electric motor in 1831. Jacobi, in 1838, drove a small paddle-wheel boat in the Neva, Russia. Professor G. C. Page, of the Smithsonian, in 1850, produced an electric locomotive. In 1855 Thomas Davenport, Brandon, Vermont, a blacksmith, constructed several electric motors. In 1861 Professor Pacinotti, of Pisa, built a remarkable motor. A great many different ones have been built within the last twenty years.

It only needs the same ratio of progress for the next fifteen years that the last fifteen have witnessed, to transform the great trunk-line railroads from steam to electric or compressed air roads, and to consign the locomotive to the limbo of mechanical bric-a-brac. The first electric street railway in this country was completed in Denver, Colorado, in 1884, and now it is in operation in hundreds of towns and cities.

The third rail to transmit electricity, for some time used, bids fair to introduce electro-motors into all passenger cars, and to substitute for freight trains, electric motors, and to double the speed of trains. At this writing (1899) an able article in the "Cosmopolitan" by Sidney H. Short (1857) demonstrates the success of this new and latest method of locomotion.

Electric trains will be braked by a new device, pneumatic control, supplementing the air brake, by which one motorman at the head of the train can turn off the current and stop the train. Speed, safety, economy and other advantages are thereby secured.

The electric cash drawer has been devised to meet the needs not only of banks, but small business-houses, such as restaurants, saloons, and drug and other stores. The wires can run to any point, preferably to the office, where the cabinet is placed under the control of the bookkeeper, cashier or stenographer. The drawer cannot be opened or unlocked. If a sneak thief, or any one unaccustomed to using it, attempts to open the drawer, a gong instantly sounds an alarm.

Electricity bids fair to revolutionize mining. After ten years of experiment a problem, with which Edison has been struggling, has been solved, unless the inventor himself is deceived. He has succeeded in separating the iron from iron-ore by magnetic process. By this new process there is no mining, properly speaking. The ore is simply blasted out and then pulverized by a system of steel crushers, which are

capable of converting a chunk of ore weighing a ton into powder without any difficulty. The iron is separated from the powder magnetically, and when reduced is ready for market in the form of small bricks. The process is comparatively cheap.

The deposits of iron-ore in New Jersey are sufficient to supply the needs of the United States for half a century. The problem that Mr. Edison undertook to solve ten years ago was, how to get the iron-ore out of these mountains of rock. Any one can take a piece of magnetite, pulverize it with a hammer, then hold a little magnet over it and draw up from it little black particles which are iron-ore, leaving the sand undisturbed. But to be of practical service, it was necessary to do this on a scale as colossal as the phenomena of nature. Mountains must be reduced to dust, and the iron-ore in this dust must be separated from four or five times its weight of sand, and then this iron-ore dust must be put into such form that it could be shipped and smelted. To ship dust in open cars would involve great waste, and the dust when thrown into furnaces would choke them, or it would be blown out by the tremendous blast of air necessary in smelting, and so be wasted. Mr. Edison, therefore, had three great problems to solve. He has constructed machinery which will reduce ten tons of rock to dust every minute. He has invented apparatus whereby the particles of iron-ore are separated from this dust; and after six months of almost hopeless experimenting, he has been able to compress this dust into briquettes, which are thoroughly porous and at the same time absolutely waterproof. By the solution of tremendous engineering and physical problems, he has unlocked fabulous sources of wealth from the New Jersey mountains. From the time the ore is blasted with its native rock out of the mountain side, until it is loaded in the form of commercially pure iron briquettes on the cars, it is not touched by human hands. The never ending and never resting stream of material constantly circulates through the various buildings, crushed by the stored momentum of gigantic rolls; hoisted skyward by steam, pulled earthward by gravity; deflected by magnetism, dried, sifted, weighed, gauged, conveyed; changed from rock into dust, and from dust into comprehensive lumps, mixed with a due proportion of adhesive material; churned, baked, counted, and sent flying to the furnaces by fast freight; and not once in its course is it arrested or jogged onward by human agents.

Brief reference only can be made to many of the uses of electricity in the arts, medicines, etc., electroplating, electrotyping, galvanizing, the electric battery, etc. An electric loom was exhibited by Bonnelli in Turin. It dispenses with the perforated cards in Jacquard's looms. The audiometer is an instrument devised by Professor Hughes, the inventor of the microphone, and described by Doctor Richardson at a meeting of the Royal Society of London, in 1879. Originally its object was to measure with precision the sense of hearing. Among its

constituent parts are an induction coil, a microphone key, and a telephone. Telegraph clocks are connected, any number of them, with one governing chronometer, so that all keep the same exact time. Electric annealing: in 1893, an American electrician discovered that a bar of iron immersed in a solution of sulphuric acid and cold water could be easily fused by the application of a strong electric current. The enormously high temperature of 14,000 degrees Fahrenheit, or nearly five times hotter than molten iron, has been produced. The electric alarm, or thermostat, rings a bell to indicate temperature beyond a given degree.

The field for ingenuity in electrical enterprise seems exhaustless. As lately as October, 1897, Milo G. Kellogg, of Chicago, was reported to have issued to him 125, the largest number of patents ever issued at one time to one inventor, and they all relate to switch-boards for telephone exchanges. They cover the most modern switch-board practice. One of the most startling is that the new system will permit of the handling of 30,000 lines in one main office, and with infinitely better service than is now given. Heretofore the capacity of one office has been 6,000 lines.

An electric clock consists of a dial with hands and going-train impelled by recurrent impulses from electro-magnet. The first known clock of this kind was invented by Wheatstone, and exhibited by him in 1840. Appold, Bain, Shepherd, and others have contrived clocks on the same principle.

The galvanometer is a very delicate apparatus for determining the existence, direction and intensity of currents. It was invented by Schweigger, in Germany, in 1819, just before Oersted, in Denmark, in the same year, discovered the law of directive action, which a fixed current excites at a distance on a magnetic needle. In connection with the construction of the Indicator telegraph, Ampère, Arago, Schilling, Gauss, Weber, Alexander, all used the principle, but it was carried out in a superior manner to any by Cooke and Wheatstone in 1837.

The year 1898 seems to have been the electrical year of the electrical age. Edison, Tesla, Roentgen, Marconi, one after another, these great minds are bringing stupendous things to the light. The farther the great scientists are enabled to peer into the mysteries of nature, the greater the vista of possibilities which appears before them. Says Thomas A. Edison: "With all the brilliant discoveries of the nineteenth century, we are merely groping in the early dawn. We are at the cock-crow of civilization."

It is strange that this recent run of great electrical inventions has taken the form of a series of aids in the transmission of intelligence. The latest discoveries in the world of science have added means of sending thought through space. Some of these methods are greatest on account of their scientific importance and the ultimate wonderful possibilities which they unfold. Others still are of immediate practical utility.

Latest of all the electrical tele-

graphing ideas is the invention of Thomas Barton Dixon. It offers a completed and practical solution of the greatest problem which has been retarding wire telegraphy for the last ten years—sextuplexing.

Archibald J. Robertson is an inventor who has devised a plan for electric transmission without loss of power. The result to be anticipated is that the cost of production of electricity will be reduced one-half. It will revolutionize electrical science; utilize the waterfalls of the nation as the initial motive power to drive the electric generator, and transmit heat and light regardless of distance; this, too, at a price with which the most approved method now in use for the purpose cannot successfully compete. It transmits electricity. Electricity's value hitherto has been little more than local, for the sole reason that a current suffers enormous loss in transmission over any considerable distance.

Latimer Clark is the author of 150 inventions in electrical telegraphy and engineering.

For three-quarters of the century it was thought that steam was king, and would rule the coming centuries. But all at once the world discovered that it was the age of electricity, and that steam, gas, mechanical force, and all the wonder-workers in physical science must succumb to the new giant, to whose might are being laid all the miracles of the universe, and now even the sun, the source of all force, is found out to be not a ball of fire, whose energies are due to combustion, but that the great luminary itself is an electric light. Henceforth electricity is king.

Thomas A. Edison, Jr., has produced a strange device by which he claims to be able to photograph thought. Doctor Baradue has delighted French scientists and oculists by his able pamphlet on the same subject; Professor Elmer F. Yates has expounded a novel method of arriving at the same result; Professor Marso has shown that it is possible to measure human emotions. As we write we hear of the electrical steamship, which is designed to run forty miles an hour; the signal device enabling persons on board ship to speak to those on shore; the synchronograph, the object of which is to send by telegraph as many as 3,000 words a minute; the aerial torpedo boat; the bullet-proof armor, which has been tested several times, and apparently with signal success; the non-sinkable boat; Knapp's rolling steamer; the fish-shaped steamship; and the electric horse and carriage.

Henry Wilde (1833) in early life obtained several patents for improvements in lightning conductors and electric telegraphy. In 1865 he constructed an electro-magnetic induction machine, or dynamo, as it is now designated, which he produced for the first time from carbon points and electric light. He invented the search light in use in the English navy. From 1867 to 1880 he perfected inventions for generating electricity to the electro deposition of metals from their solutions, superseding the voltaic battery in electric plating to the advantage of the oper-

ative's health. He is author of many minor inventions and valuable writings relative to invention and scientific progress.

The Gramophone, invented by Berliner, is literally a talking machine which "talks back" whatever has been talked into it. Flat discs of gutta-percha contain impressions of every sound it may be desired to preserve, and which can be repeated through this wonderful instrument; so many discs, so many sermons, songs, orations or operas; thus the great Patti can sing her immortal songs in her castle in Wales, and be heard, through the needle's point, in San Francisco and Honolulu, and a hundred other places at the same time. And so of the world's great orators and entertainers, the great thinkers, who stir the hearts of men. In fact, whatever the cities have in their theaters and churches and concert halls that is best worth hearing may be heard quite conveniently, and with only the slightest falling off in quality, by the denizens of the most remote village, by dwellers on the distant alkali plains, by lonely huntsmen in the woods—and all through the point of a needle—the needle of the gramophone, which traces the undulations of the sound-waves as they are preserved on indestructible records, and reproduces them through that wonderful little instrument. Whoever buys a Berliner gramophone buys a box at the opera, rents a pew in a city church, secures permanent admission to the best music halls in the country, can order out a dashing military band at a moment's notice, can make the great piano-players of the day his obedient servants, and can do a great many other things which would have put somebody in danger of being roasted for witchcraft had they been attempted by our forefathers.

When Dr. Franklin, something over a hundred years ago, discovered the identity between frictional electricity and lightning, and verified the fact by sending up his iron-pointed kite, great was the interest excited thereby among scientific men. But the only benefit that was supposed to be likely to grow out of the discovery was the protection of buildings from being struck with lightning. A good thing of course, as far as it went, especially as it in due time developed the modern lightning-rod man, who, on the whole, has about as bad a reputation as a plumber. But Franklin builded bigger than he knew, in the way of a foundation for others to build upon, and in due course of time one scientific discovery after another has followed step by step, and been supplemented by inventions to match until electricity may be said to be fairly harnessed to the car of human utility in a great variety of ways, and it is fair to presume that its utilities are only partially known even yet, and that while we are a great way ahead of Franklin's achievements, we may still be as far behind what will be in the future, as the past of Franklin's time is behind the present.

Electricity is the cheapest and most obedient and efficient of man's servants. No cinders, no smoke, no fire if the train is wrecked, it as far

excels steam as the steam-engine excels the ancient methods of locomotion. Electroplating is now an easy art. Printer's type, stoves, almost any article, can be covered with nickel, copper, gold or other metal, so as to become to the eye as beautiful as the precious materials can render it. The mountain road up the Jungfrau ascends 13,000 feet, by electric power, and other mountain roads are numerous—Mount Lowe, California, etc.

The street railway is continually becoming more nearly perfect. The engineer whose plans have been adopted for the electrical equipment of the Brooklyn elevated railroad system is S. H. Short, who is now engaged in designing the third rail and motor car system for the Manhattan Elevated Railway of New York. Mr. Short is known to electrical experts as the inventor of the earliest long-distance telephone transmitter, and of the gearless motors of the electrical locomotives used in the Baltimore and Ohio tunnel; also as the builder of the first commercial electrical railway in the United States. At the age of forty he has built more trolley roads than any other man in the world, has founded and operated electrical companies of his own, and has sold to the Edison and Bell companies patents, which have brought him a fortune. The electric railway was originated in Berlin in 1879 by Siemens and Halske.

The radiotelegraph of Dr. Oliver J. Lodge, of England, and of Marconi, of Italy, is a wireless telegraph. Its objection seems to be that its waves, once started, fly all over the radius exposed to their influence. In a demonstration at Liverpool, they caused great disturbance on the telephone lines, and had to be stopped in consequence. Professor Lodge's improvement is to confine the action of the signaling waves to the one particular receiver that is "tuned" to respond to them. By tuning the receivers to a particular set of waves any number of messages can cross each other in all directions, like waves in water, each being received on its particular instrument at its proper destination. In Marconi's apparatus the waves are quickly damped or weakened, and so deprived of their ability to travel over long distances. Dr. Lodge is producing appliances, which, he claims, will reduce this damping effect.

The fire alarm telegraph was first used in New York and Berlin, in 1851. The present system was introduced by Farmer and Channing in 1857.

The electric burglar alarm was invented by Bonelli in 1852, in Turin.

A Galician school-teacher, Herr Szczepanik, is reported to have solved a problem over which many leading scientists have labored in vain for years. It is announced that he has perfected an apparatus which will not only transmit pictures by wire, but which will transmit moving images in all their natural colors. That is, the apparatus is so all-sufficient in operation that if a man were to bow to the transmitter in New York, his image in the act of bowing would be reproduced on a screen in Chicago, or in any other city to

which the line might extend. His facial expression, his clothes, his very wink, would be accurately transmitted. Indeed, it would seem that at last we are to be able to see by wire, and a detailed description of the apparatus shows that the performance is, after all, a very simple one. An English patent attorney says that Herr Szczepanik, the inventor of the process, has been offered over $1,000,000 for the right to exhibit the apparatus in the Paris Exposition of 1900. It is also said that the inventor perfected his theory of how images and colors could be sent by wire in one night. This is indeed wonderful, in view of the fact that Alexander Graham Bell has been at work on a similar process.

Rudolf Eickemeyer (1831) has devised a useful dynamo for elevators, hoisting apparatus, etc. He has also invented an apparatus for almost every stage of hat-making, shaving machines, stretchers, blockers, pressers, wirers, and sewing machines, that substitute mechanism for hand work. His dynamos for electric lights on railway trains, his storage batteries, etc., are valuable contributions to the inventions of the age.

Elihu Thomson, an American, has succeeded by means of the electric arc in revolutionizing the old process of welding. He has practically vacated the blacksmith shop of the future. He has shown the old style forge to be a very unnecessary institution. In order to weld nowadays it is only necessary to pass a very powerful electric current through the two pieces of metal which are to be joined together. The rivet has been banished.

Ruhmkorff (1803-1877) in 1864 invented the induction coil, for which he received the prize of $10,000 offered by Napoleon III.

Gramme is the inventor of the magneto-electric machine, for electroplating, for moving railway brakes, for telegraphing, for producing light, etc.

Professor Roentgen, of Warzburg University, invented (in 1896) the X-ray or Roentgen ray, which will penetrate and render transparent wood and flesh, and will not penetrate bones and metals. (See "Photography.") It is caused by an electric spark passing through a vacuum tube. It locates bullets, or any metallic substance in the body, and determines manifold abnormal conditions. *A priori*, it is incredible, but in fact it is one of the greatest of modern medical achievements. It is evident that medical science is on the eve of an advance transcending all previous progress. The twentieth century promises more for the victims of disease than all the previous centuries could offer. (See "Medicine," "Photography.") These magic rays are produced by a current of electricity sent through a tube composed of semi-transparent material, which causes a light, not only intensely bright, but of such peculiar qualities that it will pass through hundreds of pages of paper, or through glass or tin, of equal thickness. Its chief value is in examining the animal body. Flesh and skin are transparent, while the bone is visible. Any injury to the

bone, or an obstruction in the body, as a bullet or other foreign substance, can be located. In the surgeon's hands it becomes a means of marvelous power over disease and injury.

On March 29, 1899, Guglielmo Marconi conducted successful experiments between the South Foreland County of Kent, and Boulogne, France, at the mouth of the Lianne, without wires. The experiments were conducted with the Morse code, which was read as distinctly as if the termini had been connected by wires. The distance from South Foreland Lighthouse to Boulogne-Sur-Mer is thirty-two miles. An experience of fourteen months had shown Marconi that no kind of weather in England would stop the working of his apparatus. The vertical conductor he uses is the main feature of his system.

In 1897 wireless telegraphy was first established. Service was set up between the Isle of Wight and Bournemouth. These two stations are eighteen miles apart. During the Prince of Wales' sojourn on his yacht in the bay at Cowes (Isle of Wight) regular communication was maintained between him and the queen, who was spending the summer in her palace at Osborne, two miles from the beach. In March, 1899, the first communication was effected between England and the continent of Europe. A French war ship— the Vienne—sent messages without hitch of any kind to England, a space of forty-two miles, and to France, over a space of twelve miles. In 1899 the international yacht race was telegraphed successfully by Guglielmo Marconi, the genius who developed and perfected this great discovery.

Tesla's latest announcement is that he is able to shoot millions and tens of millions of volts of real thunderstorm lightning through a man, that will melt glass and fuse metals, and yet give him no injury or pain. More wonderful still, that all this mighty force which a human being can withstand, will destroy microbic life and disease germs within, making one's system as clean and sweet as atmosphere after a thunderstorm.

The steps of progress in electricity have been successive. Each has built on the discoveries of his predecessor. Oersted discovered that the magnetic needle could be deflected by a current; Arago and Davy that iron and steel could be magnetized by the passage of the current through the wire bound around them; Barlow (1826) revolved a wheel by electricity; Henry (1831) built the first electromotor; Jacobi moved a boat on the Neva in 1838; and Pacinotti in 1861 evolved the best motor then known.

Electricity is the force that moves the telegraph, the telephone, the railway car, the land carriage, the printing press; that fires mines and torpedoes, electroplates, engraves, administers the shock to the human system that brings health, and the fatal shock that extinguishes the criminal's life, and is rapidly advancing to become the chief servant of man in all human affairs. The coming king is the Dynamo. Its name bids fair to be Legion, for al-

THE ELECTRIC LIGHT.

"The illumination of the Court of Honor at the Omaha Exposition was an inspiring example of electric lighting."

A WHALEBACK.

ready there are scores which inventors have produced. Some of the principal dynamos are the invention of Bradley, Brush, Dessozier, Edison, Rudolph Eickemeyer (1831), Ferranti, Forbes, Fritsche, Ganz Goolden, Hochhausen, Kennedy, Kingdon, Mathew Sperry, Waterhouse, Wenstrom, etc.

And yet there is every indication that the twentieth century will not be far advanced when compressed air will have superseded both steam and electricity as a motive power. The Hoadly-Knight patents are already being introduced to propel cars on street railways.

Assistant Commissioner of Patents Greeley, under date of July 21, 1899, writes: "The age of electricity is only just dawning, and one advance in this direction which we are about to witness is the conversion of the steam railroads of this country into electric railroads—a change that would have been accomplished already to a large extent but for the immense amount of money invested in locomotives, and the first enormous expense of installing an electric plant. Cars have already been run by electricity at a rate exceeding sixty miles an hour, and electric locomotives have proved themselves superior to those depending on steam power. One advantage of the electric locomotive engine is that it emits no smoke or cinders, and the water power of any river within a few miles of the line may be utilized, instead of fuel, to run it.

"The first electric road for city or suburban traffic was put in operation a dozen years ago; at present there are in the United States more than 15,000 miles of such roads, representing a total investment of $900,000,000, and employing about 175,000 persons. In 1880 there were only three electric light and power establishments in this country; to-day there are more than 10,000 such establishments, employing 50,000 men and $500,000,000 of capital. The telephone in 1880 was just beginning to be commercially known; now there are over 1,000 exchanges, using 600,000 miles of wire, and employing 15,000 individuals and $85,000,000 of capital.

"Electricity is invading all the arts and industries. The manufacturer finds it more economical to attach a motor to each of his machines, distributing power through his factory by means of wires. Coal is now cut in the mines by electric power, carried to the pit's mouth by the same agency, and loaded upon electric cars for transportation. The demand for copper for electrical uses is mainly accountable for the fact that the output of this metal in the United States has been multiplied by six since 1880. To make a telephone circuit from Boston to Chicago requires over 1,000,000 pounds of copper.

"Many marvelous things are being accomplished with metals by the aid of electricity, among which may be mentioned the welding together of such substances as steel, copper, nickel, etc.—a task that was deemed impossible until recently. With the employment of the electric arc a new chemistry of high temperatures is in prospect, promising fresh dis-

coveries of high industrial value. By this means a heat of 7,200° Fahrenheit is attained, which is sufficient to reduce all known substances. Hence the electric furnace in which gold, iron, platinum, and copper are volatilized, and by the help of which actual diamonds have been manufactured from charcoal.

"Already we have learned how to send seventy-two messages simultaneously over a single wire. We can transmit the handwriting of an individual by telegraph, and in the same way we can actually reproduce half-tone pictures at long distance. Before long we shall be able to reproduce full typewritten pages by telegraph, just as we now send words on a paper ribbon, and wireless telegraphy seems to be in sight. When the proposed Pacific cable is laid it will be practicable to send a message around the world in three seconds, and it is promised that a method will be found for telegraphing between ships miles apart at sea. Even now it no longer seems so wonderful that, by the touch of a button at the Naval Observatory in Washington each day at noon, 100,000 clocks all over the United States should be set to the true time, while time-balls are dropped at the same instant at all seaports on the Atlantic and Pacific coasts for the benefit of mariners.

"The great problem likely to be solved in the twentieth century is the transformation of heat into electricity direct. When this is accomplished, Biddy in the morning will start a fire, the heat of which will fill a series of storage batteries that will do most of the work of the household during the day, illuminating the dwelling, propelling the machine fans, running the sewing machine, operating the dumb waiter, and so forth. This, however, is only a faint suggestion of the advantages to be gained by the discovery I speak of.

"The homes of many rich men today are run to a great extent by electricity, which lights them, ventilates them, and even operates the family elevator. This kind of elevator is itself a new invention; it has no attendant, but is so controlled by the invisible force stored in great jars of lead and acidulated water in the battery-room that it is as safe and docile as any well-trained servant. Anybody who wants to make use of it presses a button, and the car comes responsively to the floor desired. Stepping aboard, the passenger touches one of a series of buttons inside, and the car transports him to the floor he wishes to go to. If the promises of electrical experts are to be accepted, our dwellings before long will be lighted by electricity without wires.

"An extremely valuable product of the electric furnace, by the way, is carborundum—now being made in a large way at Niagara—which is the hardest of all substances save the diamond, and, therefore, serves extremely well as an abrasive. By electrolysis aluminium is separated from its ore, and thus has been brought to a point of exceeding cheapness, while by the same means ordinary brine is separated into two valuable products—chlorine for

bleaching, and sodium for soap manufacture.

"Electricity is now recognized as a most useful agent in medicine, being employed in a great variety of ways. In some complaints it has a remarkable power of stimulating function, and it has been found that certain drugs put on a moistened electrode can be carried into the body with the current, so as to benefit directly a diseased part. Various kinds of morbid growths are removed instantaneously and painlessly by electro-cautery, and the only successful method for getting rid of superfluous hair is that of the electric needle, which is gently introduced into the hair-follicle, and kills the root. Nowadays operative instruments for the nose, mouth and throat, whether drills, saws, or what not, are controlled by electricity, while tiny incandescent lamps, swallowed by the patient or otherwise manipulated, are utilized to illuminate the cavities of the body and head, so as to reveal conditions to the physician.

"Street cars are not only run by electricity, but are illuminated and heated by the same agency. The heaters used for this purpose require no attention, regulate the temperature exactly as it may be wanted, and, when used on railway trains, do not endanger the safety of the passengers. One of the latest improvements is to provide each berth in a sleeping car with an incandescent light, so that one may read if slumber comes not. Similarly, incandescent lights are now provided for carriages, and they are even coming into use for cabs. The Emperor of Germany has his closed carriages lighted in this way, and, in addition, the harness of his horses are covered with small glow lights of different colors, so as to produce a beautiful effect.

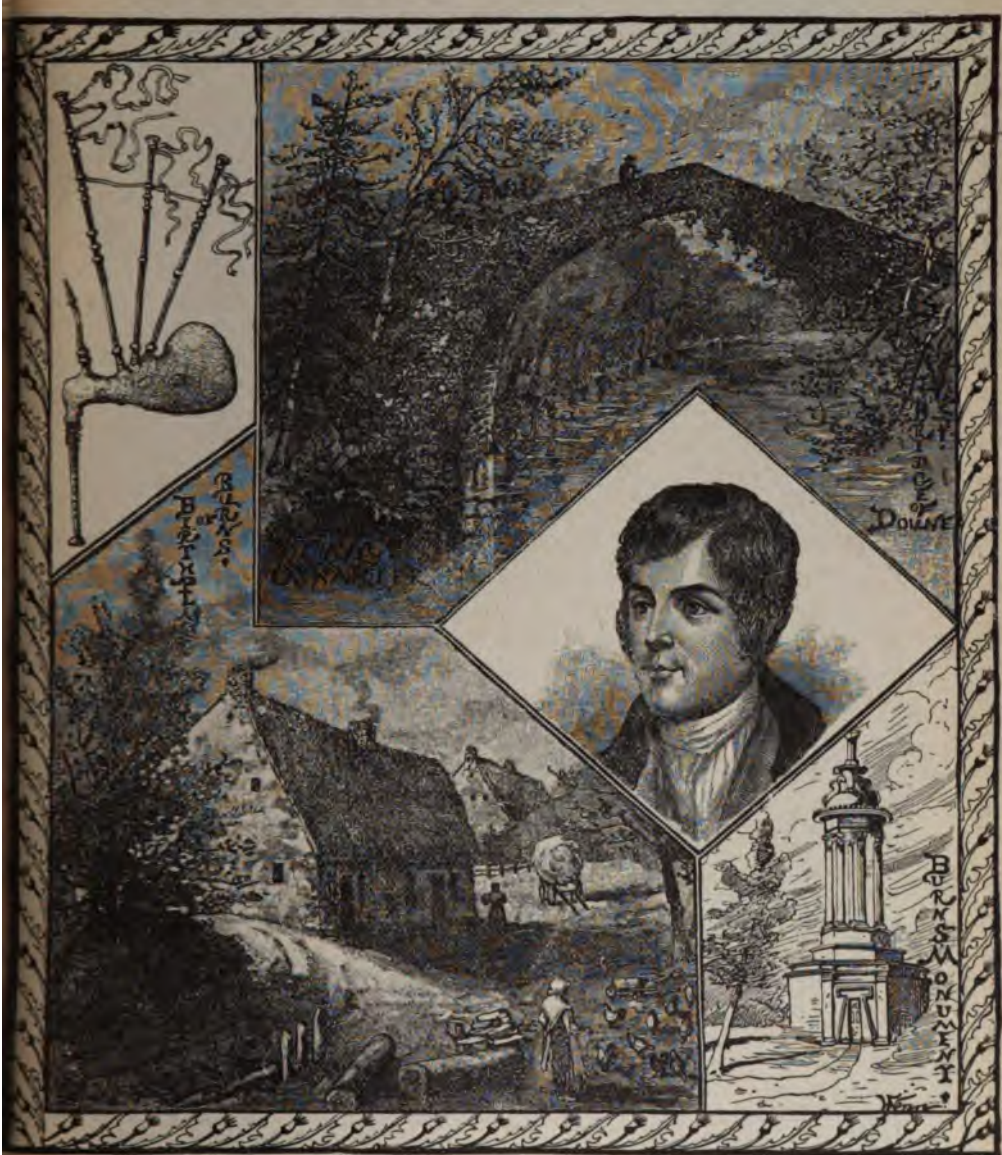
"The twentieth century will see electricity introduced in the kitchen in place of coal and wood. In order that this may be accomplished it is only necessary that the fluid should be made a little cheaper, inasmuch as it serves much better for all culinary purposes. The electric oven bakes bread ideally, and meats prepared in it do not require basting or watching, while broiling or frying may be done in superior style on the electric range. The electric chafing-dish is attachable at a moment's notice to an ordinary light-wire; the current is turned on, and immediately the oysters begin to stew or the eggs to frizzle. In the electric kitchen of the near future there will be no coal, no ashes, and no smoke; there will be no fuel, and not even a battery, inasmuch as the requisite current will be furnished from outside, as gas is now. The sad-irons used on Tuesdays for the family linen will be heated by electricity and will be kept thus at a constant temperature, so that they will never scorch things and will not require changing or reheating. Already we have electric curling-tongs, which, being hitched to a light-wire, are warranted not to singe the hair.

"Electric boats are now plying on the canals of Venice, and launches similarly propelled are being made for American warships, the power

being derived from storage batteries beneath the seats. The trolley, meanwhile, threatens to supplant the industrious but uncertain mule for the propulsion of canal boats. In the cities canned electricity, as it might be termed, is now delivered to consumers, the emptied batteries being taken away every day and replaced with full ones. At the same time, agricultural machines run by electricity are being introduced to the farmers, and there is even a device for the wholesale electrocution of weeds. Among recent inventions are an electric churn and an electric incubator, and experts are making experiments in the forcing of the growth of plants by electric lights and by under-ground currents."

ROBERT BURNS.

[Born 1759. Died 1796.]



"Let me write the songs of a people, and I care not who make the laws," is an observation shrewdly applicable to the genius of Robert Burns. Where, indeed, upon the broad roll of names eminent in song, is there to be found a national poet whose memory is so tenderly cherished by his countrymen as is that of the humble Scottish bard? Where is there another whose simple lays are so often on the lips or so highly treasured as his? Wherever you find a Scot his eye lights up at the mere mention of the name of Burns.

CHAPTER XIX.

THE MICROSCOPE.

HISTORY OF THIS GREAT REVEALER AND ITS INVENTORS — PASTEUR — KOCH— WHEATSTONE—DOLLOND—BREWSTER—SCHLEIDEN—WOLLASTON, ETC.

NO means of scientific research has made more important improvement in the same space of time than has the microscope. During the second third of the present century it was developed from a mere magnifying glass to a degree of perfection worthy of its name. The compound microscope is now a wonderful instrument. It has kept pace with the telescope, and has unfolded to human ken, in the near and minute, what the telescope has revealed in the vast and remote. Up to the beginning of the century it was a toy in the hands of the curious. Brewster had thought of gems as lenses to overcome the defects of glass. In 1812 Wm. Hyde Wollaston (1766-1828) suggested two plano-convex lenses, and the instrument was known as "Wollaston's doublet," and further improvements produced "Wollaston's periscopic." Herschel, in 1821, J. J. Lister, with crown and flint glass from 1824 to 1830; Amici (1827), Lister, Robert Brown (1833), and others rendered it the valuable instrument it has become. It was not much used as an instrument of discovery until 1823, when Sellilques and Chevelier, of Paris, and those above named, especially J. J. Lister in 1838, had rendered it achromatic. What wonders it has since revealed, not only showing that the Creator is *maximum in minimis*, but adding immeasurably to human knowledge and welfare!

Professor M. J. Schleiden (1804-1881) in 1837 employed it in vegetable physiology. Ardouin in the same year discovered, by its help, animalcular life in the fungi in silkworms, potatoes, vines, etc. Varley and others made most interesting and important discoveries, as did Hofmeister, Thuret, Decaisne, Tulasne, Milne-Edwards (1800-1885), and others. Within the last thirty years have been wrought the most amazing developments, and wonderful discoveries have been continually accomplished by biologists and chemists, as will appear on other pages of this book. In fact, the wonders revealed seem but prólogues to the vast domains that stretch out beyond the threshold which science has revealed, and to which the microscope marshals the way. (See "Bacteriology," "Medicine," etc)

The discoveries in chemistry and physiology that have been made have rendered these sciences new. The microscope has shown the red corpuscles of human blood to be bi-

concave disks; and under the lead of Schleiden, Schwann, Johannes Muller (1801-1858,) Nägeli, Kölliker, Unger, and Virchow, demonstrated that all vegetable and animal life is the multiplication of cells, a discovery that was truly epochal in the development of physiology—the great physiological generalization of the century. (See "Chemistry.")

The discoveries along these lines in vegetable and animal physiology have been more numerous and astonishing during the last half-century than all that mankind had previously made in those realms.

Until within a very few years the causes and nature of disease were so inscrutable that any attempt to investigate them seemed hopeless. The first clew to a method of investigation was afforded by the microscope, which showed that the air and water were replete with minute organisms. This fact once fully grasped, and these organisms made the subject of investigation, the idea that they might influence the health of individuals very naturally followed. On this hint bacteriology soon became a science; the work of Louis Pasteur (1822-1895) and Joseph Lister (1827——) followed in regular course, and the duty of the medical profession rose from the administration of pills and potions of doubtful efficacy to that of pointing out the dangers which surround us in the sputum of the consumptive and the water of the city. Every well-appointed medical college now has its bacteriological laboratory, where studies of the germs of disease are pursued both by the professor and the student.

The power of the microscope may be estimated from an assertion that the minutest animalcule is 34,560,000,000,000,000,000 times smaller than a whale; and there are at least 100,000 species of animalcules. We have been able to deduce from observations made by it that some animalcules propagate so rapidly that one of them in four days would produce over 70,000,000,000 of its species. It also shows us that 300,000 of these animate bodies may inhabit a drop of water.

The world was astonished by the discoveries of Pasteur in regard to a disease which was very fatal among sheep. The microscope was brought into use to solve the problem, when it was found that the disease was owing to a parasite; the discovery led to the cure. He weakened the parasite virus by exposure, then inoculated the sheep with it, and the result was that the epidemic was arrested. Koch, a German savant, brought this instrument into use to locate the cause of pulmonary consumption. He found that the matter expectorated from the lungs of this class of consumptives contained an enormous number of minute parasites, known as bacilli. A series of experiments was conducted, after the principle of that of Pasteur, and it is hoped that in time, by inoculation, this scourge of modern civilization will be mitigated, if not wholly obliterated.

In a compound microscope an image of the object is first formed by the objective, and afterward en-

larged by the lenses constituting the eye-piece. Till about the year 1830 the object-glasses of the microscope were mostly formed of the single or combined lenses, the apertures of which, in order to obtain a distinct image of the object, were exceedingly small. The labors of modern opticians to adapt the achromatic principle to compound microscopes were rewarded by the construction of lenses, in which the images of objects were rendered distinct in their minute details, even when high magnifying powers were applied. In a modern microscope objective, not only is the color corrected and the image free from distortion, but by an increase in the angle of aperture, the penetrating power of the objective is considerably increased, and less magnifying power is required from the eye-piece. With a good objective of one-eighth of an inch focus, magnifying powers ranging from 450 to 1,200 diameters can be obtained by using different eye-pieces.

The oxyhydrogen microscope was invented in 1832. The Drummond light, a stream of oxygen gas and one of hydrogen gas, are projected on lime, in an ignited state, and an intense light is produced, which, passing through a lens, magnifies objects 100,000 times, upon a screen. A bee's sting is four feet long; the Lord's Prayer has been micrographed by Webb, in London, on 1-129,654 of an inch, or, at the rate of 29,431,458 letters to an inch, which would, at that rate, contain eight Bibles on one square inch.

"There is something in the extreme of minuteness, which is no less wonderful—might it not be said no less majestic than the extreme of vastness? If the mind loses itself in the contemplation of the immeasurable depths of space, and of the innumerable multitudes of stars and systems by which they are peopled, it is equally lost in wonder and admiration, when the eye is turned to those countless multitudes of living beings, which a single drop of water may contain."

The great variety of microscopes with which the eye explores, in realms invisible to unaided human vision, are all the product of the inventive skill of the Nineteenth Century.

Charles Wheatstone (1802-1875) invented the stereoscope in 1833; Brewster (1843), O. W. Holmes and others improved it.

The Pseudoscope, Phenakistiscope, Telestereoscope (invented by Helmholz) are curious optical instruments, akin to the stereoscope.

The camera lucida was invented by Dr. Wollaston in 1807.

George Dollond (1774-1852) was inventor of the achromatic lens.

The Kaleidoscope, though originated by Giambattista Porta (1538-1615), in the sixteenth century, was perfected by Sir David Brewster (1781-1868) in 1817. It is an instrument which, by means of reflection, enables us to behold an endless variety of beautiful forms of perfect symmetry. It is made by taking two plane mirrors, usually formed of slips of glass, blackened at the back, from six to twelve inches in length, and diminishing in breadth from

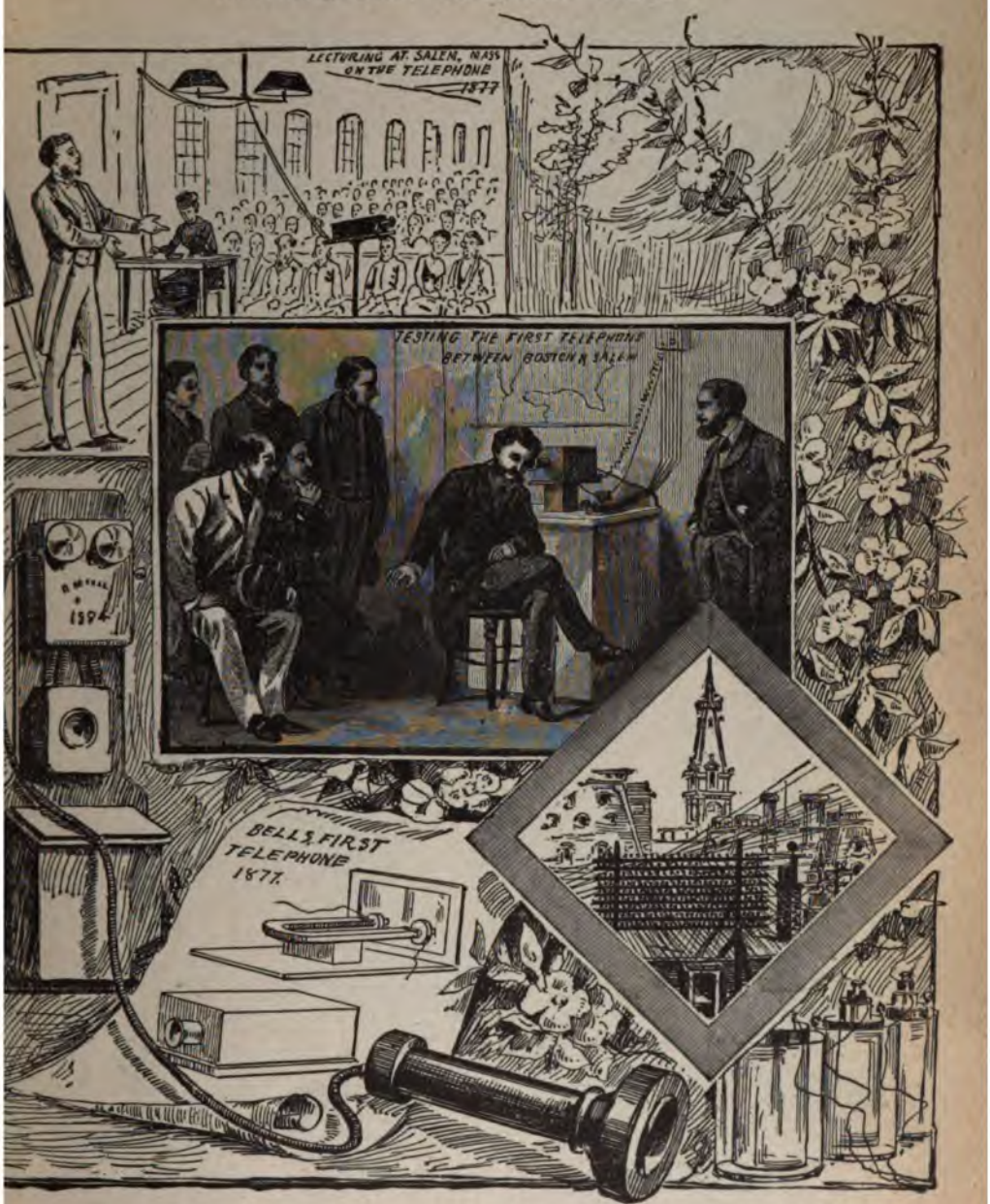
about three inches or one and one-half at one end, to one or three-fourths inch at the other. Some varieties of the instruments are: (1) Polyangular kaleidoscope: Here the reflecting mirrors are so arranged that their angle of inclination can be altered by screws attached to the outside of the tube at pleasure, and it is in this form that the instrument best illustrates the theory of reflection, and therefore is largely used for scientific instruction.

(2) Polycentral kaleidoscope: Here more than two mirrors are employed, but not ordinarily more than four. They may be of trapezoidal shape, and form a hollow pyramid, or rectangular, forming a hollow cube. By this means the images produced by reflection of the objects in the box are greatly multiplied, and more complicated patterns formed. Dr. Roget was the inventor of this instrument.

(3) Telescopic kaleidoscope: Here the object box is removed and its place taken by a tube, capable of being lengthened or shortened by an external screw, and fitted at its end with a double convex lens. The instrument can thus reflect any objects (trees, flowers, etc.) which are brought into its focus.

One of the most interesting of modern discoveries is the polarization of light. In 1808, E. L. Malus (1775-1812), looking through a crystal of Iceland spar, made a few simple observations which resulted in his founding a new science, that which treats of polarized light, which opened the way for a large number of interesting discoveries, which we cannot here describe.

ALEXANDER GRAHAM BELL.



Mr. A. Graham Bell's own account of his discovery of the telephone is substantially the following. It is not the result, he says, of a spontaneous and fortunate conception, but of long and patient studies in acoustic science and of the labors of the physicists who preceded him. His father, Mr. Alexander M. Bell, of Edinburgh, had already made this science a study with the most interesting results, among which that of instilling into his son a taste for these experiments must take a foremost place.

CHAPTER XX.

CHEMISTRY.

WONDERFUL PROGRESS IN—PRIESTLEY—DALTON—DAVY—BREWSTER—FARADAY—COAL—GAS—PETROLEUM—PHOTOGRAPHY—LIQUEFIED AIR—ALUMINUM—NEW METALS.

AS astronomy was evolved from astrology, so was chemistry from alchemy. The first chemists were supposed to deal with evil

MICHAEL FARADAY.

spirits, and it was not until comparatively recent years that their researches were removed from attempts to transmute baser substances into gold, and to discover a universal solvent and the philosopher's stone, to discovering "the thoughts of God" in the realms of nature. It is the science of sciences in all that relates to life, its necessities and luxuries. No less an authority than Sir David Brewster was still of opinion that light and radiant heat were agents of two separate kinds, so that we could strain the heat out from the sun's rays and leave only light. The proof that this could not be done, that a given ray was at the same time light and heat in itself, and therefore could not cease to be either without ceasing to exist, is one of the scientific results of the middle of this century.

Says F. B. Wilkie, in "The Great Inventions": "As to the value of chemistry in practical life, or as to its value in the development of civilization, there is no necessity of saying a word. It is to-day an element in human development whose absence would be almost fatal. In the detection of cases of poisoning its

DRIVING A NAIL WITH ALCOHOL FROZEN BY LIQUID AIR.

assistance is invaluable. By its aid the pharmacopœia has been enriched beyond estimate. In commerce,

manufactures, and the trades, it is of incalculable value. It discovered malt, glucose, glycerine, uses for petroleum, anæsthetics, and artificial ice. It analyzes ores, pronounces on their value, and directs their smelting; from the refuse of the gas manufactories it has obtained materials so valuable that the making of gas for the sake of the residue would be valuable were the illuminating product given away. It discovers adulterations in food and in liquids; it gives the formula for the 'baking powder;' it has discovered all the thousand dyes in use in stuffs for wear; it bleaches cloths, it washes them; it disinfects the nests of epidemics, prevents the spread of disease, is the principal assistant of the sanitarian; it purifies the food we eat and the air we breathe; furnishes the soap with which we wash, and in ten thousand other ways and methods is an ingredient in the ornamentation, the utilities, the comforts and luxuries of life." Chemistry was really born in the present century.

The nineteenth century must claim Dr. Joseph Priestly (1733-1804), though he died in its beginning. He began his public life as an Episcopal clergyman, but soon became a Unitarian. He was a most voluminous polemical writer on a great many themes, and his house and chapel were burned by a mob, when (1794) he came to America. He discovered that atmospheric air that has been poisoned by animal respiration can be restored by plants—that the consumed oxygen will be thus supplied, and he also discovered oxygen. He died after an illness of two years. In his later years he was very prominent as a Unitarian writer and speaker.

John Dalton (1766-1844) initiated the century's progress in chemistry that has since surpassed all the advances of the previous centuries. Beginning by investigating the rainfall and the process of evaporation, he advanced to the discovery of atoms, or the laws of chemical combination in multiple proportions,—the atomic theory on which modern chemistry is founded, as great a step as Newton's, from the falling apple to the law of gravitation. This discovery he made in 1808, and announced in a paper read before the Literary and Philosophical Society of Manchester, in England, October 21, of that year. It was one of the most important chemical discoveries ever made. His law of multiple proportions, and Gay-Lussac's law of combining volumes, gave a great impetus to chemical knowledge.

Joseph Louis Gay-Lussac (1778-1850) in 1809 discovered that gases always combine in definite proportions, and this discovery corroborated and reinforced Dalton's discovery, though the latter rejected the new announcement. The same discovery was made by the Italian, Amadeo Avogadro, who generalized that the two discoveries complemented each other, and to him we are indebted for the announcement of the molecule. In 1811 Avogadro made the important distinction between the atom and the molecule, and in 1815, André Marie Ampère (1775-1836) mathematically calcu-

lated the law of their relations. At about the same time the Scotch chemist, Thomas Thomson (1773-1852), and Johan Jakob Berzelius (1779-1848), the Swedish chemist,

SIR HUMPHRY DAVY.

by analysis and extensive research demonstrated the new theory, and it is now universally accepted. Whatever doubts remained after the demonstrations of Berzelius were set at rest in 1819 by Pierre Louis Dulong (1785-1836) and Petit, French, and Eilhard Mitscherlich, German (1794-1863), whose discoveries in heat and crystallization gave that "assurance" which made "doubly sure" the discovery of Dalton, whose name ranks among those of the world's great chemists and physical philosophers.

Among the contemporaries of Dalton, no one was more brilliant than Sir Humphry Davy (1778-1829), who electrified the generation in which he lived. With his voltaic battery he transformed potash into a metal that floated on water. This he did by decomposing the potash, and extracting the oxygen from its metallic base, potassium. He treated soda and other earths in the same way, and reached the generalization of the binary composition of all chemical compounds, a theory which subsequent discoveries disproved. He conferred a boon upon humanity in inventing the "safety lamp," by which multitudes of lives have been saved from exploding fire-damp. He found that the flame of the miner's light—or the damp itself—could not pass through tubes of a certain diameter; then that the length of the tubes made no difference; and finally that wire gauze answered the purpose. Thus he constructed the safety lamp—a wire gauze around the flame of the lamp—a perfect protection from the deadly explosion of the fire-damp. He perfected this valuable invention in 1816.

P. E. Marcelin Berthelot (1827) is the greatest among the scientific

JOHN DALTON.

men of France. He is the founder of organic chemistry. He began by inquiring into the synthesis of alcohol and of fats. Prior to his time, chemists had analyzed. Berthelot

took the parts and put them together after his predecessor had spent infinite patience in separating them. In that much he was original, and in being original he was everything. The great French chemist is now (1899) seventy-four years old. He is a native of Paris, and his father was a physician. Chemistry attracted him when he was a mere lad, and he devoted himself to it wholly. His researches in nitro-glycerine and dynamite have been of vast value to science. Berthelot was one of those who discovered smokeless powder. The title of his principal work is "Chimie Organique Fondee sur la Synthese."

Sir David Brewster (1781-1868): This great philosopher did his chief work in the science of optics, in which he made his inquiries respecting (1) The laws of polarization of light by reflection and refraction; (2) The discovery of the polarizing structure induced by heat and pressure; (3) The discovery of crystals with two axes of double refraction; (4) The laws of metallic reflection; and (5) Experiments on the absorption of light. Those who were best qualified to estimate the value of his discoveries were not slow to acknowledge them; and the principal ones were the discovery of the connection between the refractive index of the polarizing angle, that of biaxal crystals, and of the production of double refraction by irregular heat. The non scientific public highly appreciated his invention, in 1816, of the kaleidoscope, a toy equally elegant and philosophical, for which there was for some time so large a demand in England and America that the supply could not keep pace with it. He did not actually invent the stereoscope, which is due to Wheatstone, but he so improved it by suggesting the use of lenses to unite the dissimilar pictures, that the lenticular stereoscope, now exclusively in use, may be said to have had him for its inventor. But the optical researches of Brewster had a far more important result in the vast improvement of light-house apparatus. Fresnel was laboring at the same time with himself for the like object in France, and was the first to put the improvements contemplated into operation. But it is certain that Brewster described the dioptric contrivance in 1812, and pressed its use on those in authority in 1820. It was finally introduced into English light-houses by his earnest efforts; and his memory justly deserves the tribute paid to it by his successor as head of the University of Edinburgh, who said: "Every light-house that burns round the shore of the British Empire is a shining witness to the usefulness of Brewster's life." "His scientific glory," said Professor Forbes, "is different in kind from that of Young and Fresnel: but the discoverer of the law of polarization, of biaxal crystals, of optical mineralogy, and of double refraction by compression, will always occupy a foremost rank in the intellectual history of the age."

Michael Faraday (1791-1867): Working at his trade of bookbinder Faraday became interested in chemistry, and obtained the beginnings

of philosophy by snatches from the books he bound. He attracted the attention of Davy, and soon excelled his teacher in successful experimentation. In 1825 he published a paper in the "Philosophical Transactions," in which he announced the discovery of "benzole" and other hydrocarbons. This oil, also called "benzine" by Mitscherlich, was obtained by Faraday from among the oils condensed from oil gas at a pressure of thirty atmospheres. It can also be obtained from the benzoic acid, which is in turn made from gum benzoin, a sort of resin which comes from Sumatra. The importance of benzole is that it led to the discovery of a series of allied substances, one of which is aniline, the base of several beautiful coloring matters. The manufacture of aniline dyes is now quite a notable branch of industry.

The correlation of the physical forces is now an established principle of scientific knowledge. All forces are known to be convertible into one another; heat is a "mode of motion," etc. Dr. Joule was the first to fully demonstrate the doctrine, though it had been hinted by Bacon, Lockyer, Rumford, Franklin, and others. Later, Oersted, Ampere, Grove, have demonstrated, as Grove declared in 1842, that "light, heat, electricity, magnetism, motion, and chemical affinity are all convertible material affections. Assuming either as the cause, one of the others will be the effect. . . . Cause and effect, therefore, in their abstract relation to these forces, are words solely of convenience; we are totally unacquainted with the ultimate generating power of each and all of them." We now know that force is never destroyed, but that when one disappears it is simply translated into some other form. Like matter, force is indestructible. Joule, Grove, Mayer, Crookes, and many others have enlarged the "boundaries of science." Others had opened or battered down gates, but it was Faraday who overthrew the time-honored walls of the old fortress of ignorance formerly called philosophy. "In his early days scientific investigators seemed to dwell in various regions rigidly kept apart. Mechanics, physics, chemistry, were studied separately, as if the realms of Nature were a triarchy of distinct governments. Each having its own peculiar code of laws, its language and its customs. Faraday abolished all this. He taught by experiments and proved by demonstrable facts that variety exists only in the outcome of natural events—that the soul, the inmost moving force, is unity. Such was the lofty ideals which Faraday set up in place of the old idols." "The greatest experimental philosopher the world has ever seen," says Tyndall. He discovered magneto-electricity, that magnets will produce electricity. Tyndall says: "The greatest experimental result ever attained by an investigator."

It is impossible here to more than hint the wonderful progress of the science of chemistry during the century. It is briefly and ably summarized in an article in "Harper's New Monthly Magazine" for October, 1897, by Henry Smith Wil-

liams, M. D., from which many of these brief data are taken.

Henry Cavendish was born inNice, of English parents (1731-1810). Though most of his life preceded the birth of this century, he saw its first decade and so belongs to it. Immensely wealthy and of noble lineage he consecrated his life to science. He discovered hydrogen and the composition of water and of atmospheric air. He burned oxygen and hydrogen mixed, when both disappeared and an equal weight of water remained. In 1828, Friedrich Wohler (1800-1882), and later, Justus Liebig (1803-1873), Jean Baptiste André Dumas (1800-1884), Charles Frederic Gerhardt (1816-1856), Augustus Laurent (1807-1853), and Louis Pasteur (1822), pursued their investigations with numbers of co-laborers until the conclusion was reached that atoms and molecules were both to be treated as units. Through their labors organic chemistry made great advances. It was then discovered that some elements coalesce with one, and others with more. For example, one oxygen atom associates with two atoms of hydrogen; one atom of nitrogen with three atoms of hydrogen; one carbon atom with four of hydrogen, or two of oxygen, and never more or less. Wohler's "synthesis of urea" was the beginning of wonderful advances along the line of synthetic chemistry.

One chemical announcement followed another, though the investigations of those whose names are already recorded, and Gustav Robert Kirchoff (1824), Robert Wilhelm Eberhard Bunsen (1811-1899), J. Norman Lockyer (1836), William Crookes (1832), John W. Draper (1811-1882), John A. R. Newlands, Gustav Hinrichs, Lothar Meyer, and numerous others. The result has been to establish the discovery of Dalton, for as yet no atom has ever been divided.

Chemical science has made most rapid and astonishing progress in the hundred years about ending, supplementing the labors of Paracelsus, Stahl, Boyle, Mayow, Black, Lavoisier, Scheele and Bertholet.

Martin Heinrich Klaproth, during his life (1743-1817), analyzed nearly 200 minerals. The synthesis of urea, by molecular transformation of ammonium cyanate, by Wohler, in 1828, also the discovery of the synthesis of cyanogen and alcohol, etc., showed that organic compounds could be formed without the aid of plants or animals. The discoveries of Wurtz, Kolbe, Baeyer, etc.; the researches of Williamson on ethers, Hoffmann on compound ammonias, Frankland on organic radicals, Kekule on the benzene series, Bunsen's spectroscopic researches, leading to the discovery of the elements, casium and rubidium, followed by the discovery of thallium by Crookes, etc., and the synthesis of alizarin and indigo, may be mentioned to give some idea of the rapid progress of chemistry in recent years.

Among the great names not mentioned elsewhere in this paper are L. J. Thenard (1777-1857), Prof. Cook, of Cambridge, Massachusetts, Schonbein (1799-1868), Schroetter, T. C. Hope (1766-1844), T. Graham (1805-1869), William Dittmar (1833),

E. H. Dubois-Raymond (1818), Robert Rawlinson (1810), and B. W. Richardson (1828). Richardson discovered the anæsthetic qualities of methylene bichloride; in 1866 he applied ether spray in local anæsthetics, and ascertained the controlling influence of nitrite of amyl over tetanus. (See "Anæsthesia.")

The microscope has been the potent ally of chemistry. Armed with this wonderful instrument the chemist has discovered what was absolutely impossible before it was perfected. (See "Microscope.")

Justus Liebig, Wohler and Jean Baptiste Dumas ascertained that every unction produced is the expression of a chemical change; Prout, in 1824, discovered hydrochloric acid in the gastric juice; Schwann found pepsin, for the first time; in 1836 Pappenheim announced the office of the pancreas and its all-importance in digesting starchy foods; in 1842 Justus Liebig learned that the true consumption of fuel is not in the lungs, but in the tissues to which they are tributary; that the red corpuscles of the blood carry oxygen; in fact not only the offices of organs, but some of the organs themselves, have been revealed by the microscope.

The great advancement in modern chemistry has furnished the physician with many efficient weapons with which to fight disease, hundreds of them, indeed, such as carbolic acid, salicylic acid, phenacetin, acetanilid, antipyrin, chloral, antituberculum, pepsin, pancreatin, sulfonal, in fact a whole arcana of antipyretics, antiseptics, hypnotics, etc. (See chapter on "Medicine.")

Among the triumphs of chemistry are the discoveries of the uses of coal tar. Aniline dye, mauveine, was first prepared in 1856 by an English chemist, Perkin. Most of the finest colors have since been developed from coal tar. Coal tar, which has originated so many dyes, also originated a long list of remedies, in the antipyretic and antiseptic classes. Carbolic acid was first found in 1834. This found, salicylic acid was developed. It had usually before been found in the oil of wintergreen. (See "Coal.")

Morichini discovered the magnetizing power of the solar rays.

William Crookes (1832) discovered the metal thallium in 1861, and in 1863 he discovered the sodium amalgamation process for separating gold and silver from their ores.

K. von Reichenbach (1788-1869) discovered paraffin and creosote.

The constitution of matter, the size of molecules, ultimate atoms, their rapid revolution in atmospheres of ether, invisible to any eye or microscopic investigation, the constant motion of all matter, though apparently immovable, the real nature of light, color, sound, heat, etc., have all been revealed to investigators during the century.

Strictly speaking, coal-gas, friction matches, petroleum illumination, aniline dyes, photography, and through that astronomy, and manifold other discoveries are due to chemical research and experiment. (See "Coal," etc.)

The absolute unchangeableness of

every particle of matter, and hence, the indestructibility of matter, is one of the conclusions of modern science. Every one of the more than sixty "elements" remains forever unchangeable. The carbon exhaled from animal lungs, for example, may enter a plant and build up its structure, and when the plant dies may wander until it helps construct a diamond and remaining a thousand years in the gem, may be released and go to plant or animal, and continue its ceaseless journey. No ultimate atom has ever changed weight, shape or size, or ever will. There are not more nor less of them to-day then there were in the primordial nebulæ, or than there will be uncounted millions of centuries hence. The absolute indestructibility of matter, and its constant fluctuations, as by chemical affinity, different particles seek each other, has been demonstrated. These are only a few hints of the triumphs of chemistry in the Nineteenth Century.

Robert Routledge, in his "Discoveries and Inventions of the Nineteenth Century," characterizes as "The Greatest Discovery of the Age," the fact that force, like matter, is indestructible, or, the correlation of the physical forces; that any natural force can produce any other. This was first taught by William Robert Grove (1811-1896) in 1842, in England, and by Doctor Meyer, in Germany, at about the same time. The theory was scientifically proved soon after by James Prescott Joule, of England, who demonstrated the indestructibility of force as Lavoisier had the indestructibility of matter. Joule's first account appeared in 1843, and was followed by Sir William Thompson, H. L. Helmholz (1821-1894) James Thomson, P. G. Tait (1831), J. C. Maxwell (1831-1879), John Tyndall (1820-1893) Balfour Stewart (1828-1887), and others, in elaborating the great discovery. The source of all energy is in the sun, and all energy is constant—"all the manifestations of force are but the transferrence of power from one position to another." As Tyndall eloquently says: "To nature nothing can be added, from nature nothing can be taken away. The sum of her energies is constant, and the utmost man can do in the pursuit of physical truth, or in the applications of physical knowledge, is to shift the constituents of the never varying total. . . . Waves may change to ripples, and ripples to waves; magnitude may be substituted for number and number for magnitude; asteroids may aggregate to suns and suns may resolve themselves into floræ and faunæ, and floræ and faunæ melt in air; the flux of power is eternally the same. It rolls in music through the ages, and all terrestrial energy, the manifestations of life as well as the display of phenomena, are but the modulations of its rythm."

Among the later developments of science few are so remarkable or of so far-reaching importance as the successful liquefaction of air, first discovered by Professor Dewar, of London. This was accomplished some years ago by English scientists, on a small scale in laboratory experiments, but it has remained

for an American scientist, Mr. Charles E. Tripler, to devise processes by which the liquefaction of air on a commercial scale is made possible and practicable. The temperature of this liquefied air is about 312 degrees below zero, Fahrenheit. One cubic foot of liquid represents about 800 cubic feet of ordinary air. Allowed to stand in an uncovered vessel in the open air, this liquid "boils away" quite rapidly, an ordinary tumbler lasting about half an hour. By protecting the receptacle with a vacuum jacket the evaporation is much retarded, the liquid lasting several hours. In the process of evaporation the containing vessel becomes thickly coated with ice, while the surrounding air is greatly cooled as the evaporation proceeds. If the liquid be confined it develops an enormous pressure, which unless managed with discretion, becomes dangerous.

Great progress has been made within a very few years in refrigerating processes. Meat is carried in a frozen condition thousands of miles and sold at a lower rate than that which is locally produced. The development of cold storage has led to the refrigeration of large buildings, some of them with a capacity of a million cubic feet or more. Electricity is widely used as an economical motive power for the refrigerating machines, both on ships and on shore, and it is claimed by those interested that the large reductions recently achieved in the cost of liquefying air have placed this new refrigerant upon a commercial basis; plans are now actually devising for cooling dwellings and hospitals by means of liquid air. Ever since the invention of refrigerating machinery the question has often been asked whether the development of the processes for producing low temperatures would not make it possible to supply artificial cold in the dwellings of hot countries. New agencies for refrigeration and new methods of applying it have been discovered. Refrigeration has been considerably cheapened. Refrigerants, perfectly adapted for the cooling of living-rooms, are known, and the details of their application for this purpose are now being worked out.

In this age of wonders it will scarcely surprise any person if the next century will be able to purchase cold when cold is desirable, just as it has always bought heat when heat was wanted.

To enumerate within the space of a brief article the possible applications of liquid air would be impossible. The most obvious application will be to purposes of refrigeration. As it produces a clean, dry cold, which can be delivered at any temperature desired, its advantages for this use are apparent. Its enormous expansive powers will make it available for driving machinery. For cooling the rooms of hospitals and private houses in summer it will be invaluable. The heat of the tropics will lose its terrors when this powerful refrigerating agent comes into commercial use. Mr. Tripler believes it has a great future as a high explosive, as a motive power for battleships, possibly for flying ma-

chines, and for many other purposes which cannot be here enumerated.

The liquefaction of gases began about 1825, when Faraday reduced chlorine. In 1883 Wroblewski and Olzewski liquefied air at Cracow; in 1898 Professor Dewar liquefied hydrogen and belium. Oxygen, nitrogen, and other so-called permanent gases, were liquefied in 1877. What is apparently new in liquefying gases is the self-intensive power of liquefaction by which a gas lowers its own temperature to the point of liquefaction by being successively allowed to escape from a higher to a lower pressure, the cooler gas returning around the tube containing the gas under pressure. Cailettet and Pictet used the so-called cascade method of refrigeration, *i. e.*, they condensed gas by means of the lowering of temperature caused by the evaporation of a second liquid gas, and so, by successive steps, they were able to reduce the temperature to a point at which air condenses to a liquid. The world is on the road toward revolutionizing manufacture and transportation.

It had long been supposed that the alkalies were oxides of unknown metals, but it was never demonstrated until 1807, when Davy separated potassium from potash. Gay-Lussac and L. J. Thenard (1777-1857) produced it more cheaply and abundantly by a different process. Soon after this discovery the three eminent scientists above named produced sodium in the same manner. Davy then ascertained that alumina, magnesia and other earths are oxides of metals. In fact, that out of the sixty-four elements of our globe fifty-one are metals.

Magnesium was first prepared in 1830 by Liebig and Bussey. It is chiefly valuable in producing light, especially in photographing in the dark. The wire burning produces a light of great intensity.

Aluminum is becoming the most important of the new metals. It was first developed by A. S. Oersted and Wohler, in 1827, but in 1854 Deville discovered the process of manufacturing it to an unlimited extent from clay. At first it was worth $25.00 an ounce, now it can be bought for a few cents a pound. It was not cheap enough to be practical till 1889, when Charles M. Hall patented a process by which it could be made at fifty cents a pound. Aluminum is really just beginning to be well known. As it is white, hard, light, untarnishable by weather or acids, it is of great value for cooking utensils, cornices, bells, cannons, smaller coins, and thousands of other uses. It could admirably replace silver, iron, brass or copper for manifold purposes, and will do so when it can be produced with sufficient cheapness. "When it is borne in mind that it is less than one-third the weight of iron and at the same time twice as strong, it will be realized that it is, at ten cents a pound, very nearly as cheap as iron, bulk for bulk. Already, for any and every purpose for which iron is used, it has the advantage of greater strength and lightness. The great Krupp gun works are said to have commenced the manufacture of aluminum from clay upon an extensive scale with a

using it in lieu of iron and the fabrication of their big d their mountings, and are from experimental tests ıvy guns made from it are o be capable of throwing a -half further than a similar ron or steel; in other words, velve to fourteen miles, in- seven to nine, and of course g with a correspondingly d force at shorter range, abling its shot to penetrate red ship or fortification easily ıs ample to withstand the iron or steel guns.

easy to understand the rev- that such artillery would ı the present appliances of and defense. Cheap and ıt, aluminum will not only onize warfare, but every- lse that depends on iron and It is said that Germany and have aluminum torpedo and that Germany has two orps furnished with alumi- ised in the soldiers' equip- nstead of heavier metals."

Age of Iron may be succeeded Age of Aluminum.

st every day develops some of rendering hitherto useless valuable. One of the most utilizations of waste is the cture of calcium carbide from t. The new process occupies ne position in the conversion cellulose tissue of wood into that the Bessemer process ı eliminating carbon in the cture of steel. The Emerson aims to first produce the from the sawdust and then to electrically smelt this with lime to form calcium carbide. It is claimed that by this process carbon can be produced in a better state of purity than by other means, and more cheaply than coal can be mined. Coke and charcoal have more or less sulphur, slate, silica, etc., which are objectionable in the manufacture of iron and steel, as well as calcium carbide. Experiments have shown the possibility of producing a practically pure carbon, and it is claimed that carbide manufactured from such carbon will produce a larger quantity of acetylene gas than carbide manufactured from coke. The success of such a process for the utilization of common sawdust opens up a new field of industry and revolutionizes the manufacture of calcium carbide.

Chemistry has created the beet sugar industry.

Chemistry averted a paper famine by furnishing substitutes for rags.

The minerals that have been discovered during the century are here given, with the dates and authors of their discovery. The list was prepared for this volume by Professor Dennis, of Cornell University:

ELEMENT.	DISCOVERED OR PREPARED BY.	DATE.
Aluminum	Wohler and Oersted	1827
Argon	Rayleigh and Ramsay	1893
Barium	Davy	1808
Boron	Berzelius	1824
Bromine	Balard	1826
Cadmium	Stromeyer	1818
Calcium	Davy	1808
Cerium	Hillebrand and Norton	1875
Cesium	Setterberg	1882
Columbium	Blomstrand	1865
Fluorine	Moissan	1886
Gallium	Lecoq de Boisbaudran	1875
Germanium	Winkler	1886
Glucinum	Wohler	1828
Helium	Ramsay	1894
Indium	Winkler	1865
Iodine	Courtois	1812

ELEMENT.	DISCOVERED OR PREPARED BY.	DATE.
Iridium	Tennant	1802
Lanthanum	Hillebrand and Norton	1875
Lithium	Brande	1820
Magnesium	Liebig	1830
Osmium	Tennant	1803
Palladium	Wollaston	1803
Potassium	Davy	1807
Rhodium	Wollaston	1803
Rubidium	Bunsen	1862
Ruthenium	Claus	1845
Selenium	Berzelius	1817
Silicon	Berzelius	1823
Sodium	Davy	1807
Strontium	Davy	1808
Tantalum	Berzelius	1824
Thallium	Crookes	1861
Thorium	Berzelius	1828
Uranium	Peligot	1840
Vanadium	Roscoe	1867
Yttrium	Cleve	1872
Zirconium	Berzelius	1824

PHILIPPE PINEL.

[Born 1745. Died 1826.]

In the pages of that masterpiece of genius and of horror, the "Inferno" of Dante, we read how those lost to salvation were tortured by every species of torment the ingenuity of the spirit of evil was capable of devising. For many centuries those unhappy creatures who had wholly or partially lost their reason were subjected by their fellow-men to cruelties which it seems impossible to think that human nature could have been guilty of. Philippe Pinel gave up all his energy and talents to the reform of the existing treatment of the insane.

CHAPTER XXI.

MEDICINE AND SURGERY.

IGNORANCE IN 1800—INSTRUMENTS INVENTED—IMPROVEMENT IN TREATMENT OF INSANE—USE OF MICROSCOPE—PINEL—VACCINATION—EDWARD JENNER—CONSUMPTION AND FEVERS—SANITARY PROGRESS.

FEW branches of knowledge have made greater progress during the century than medicine. In fact, within a hundred years the advance has been greater than during the previous thousand.

EIZABETH FRY.

How ignorantly were fevers treated, for example, even fifty years ago, compared with the intelligence with which they are now handled! Take typhus and typhoid fevers, which were then regarded as identical, until Sir William Jenner (1815-189—) discovered their difference. Water was denied, patients were kept in bed, ate all sorts of food, especially animal, beef tea, chicken broth, etc. But scientific investigation has shown that typhoid is caused by the typhoid bacillus, which makes its abode in the bowels, and that it thrives on animal food. Every particle of animal food, like oil on flame, feeds the bacilli, and increases the disease. Vegetables, gruels, furnish the bacillus no food; antitoxins destroy him, and that blessed fluid, for want of which thousands of patients have died, is freely given. Ice-water reduces the temperature, and saves many a life. Fifty years ago the physician or nurse would have denied what is now given and have given what is now denied. In typhoid and typhus fevers the improved methods of treatment save countless lives.

ELIZABETH FRY VISITING THE INSANE.

In pulmonary diseases the advance in treatment has been wonderful. The stethoscope indeed was invented during the last century, but the phonendoscope, invented in 1897 by two French surgeons, Drs. Blanchi and Badezi, is wonderfully valuable in studying the conditions of the internal organs of the body. It is declared by physicians to be a tremendous advance on the stethoscope. The phonendoscope is really an improved stethoscope, and conveys to the physician the sounds made by the internal organs more clearly, thus telling him whether they are healthy or not. The rapidity with which various kinds of food and drink are digested can also be studied accurately with the phonendoscope. This instrument locates tumors and cavities in the lungs, and fluid in the pleural organ.

The ophthalmoscope, invented in 1851, explores the eye, and locates troubles there as accurately as does the stethoscope in the lungs and heart, and the ophthalometer determines the condition of the eyes, and enables the oculist to adjust spectacles to better vision. Ruete improved the ophthalmoscope, which was first described by H. L. F. Helmholtz (1821—), in 1851. Other machines have been invented to operate on the eye.

The laryngoscope—not fully operative until 1858—enables the physician to explore the larynx and trachea, and to distinguish the character of disease, and to adjust intelligent treatment. It had been suggested in a crude form in 1829, by Avery in 1846, but was improved by Czermack (1828—) in 1856, and perfected by Louis Turk (1798—) in 1857. Its first suggestion is generally credited to Manuel Garcia. It consists of a small plane mirror on a long, slender stem, which is introduced to the back of the throat, and a large concave mirror for reflecting light.

The cystoscope inserted into the bladder renders its interior visible, and enables the operator to determine its exact condition.

The cardiograph records the pulsations of the wrist and heart; the clinical-thermometer, invented in 1850, reveals the exact amount of febrile disturbance; the speculum, perfected by Dr. G. Marion Sims (1813-1883); the pleximeter, which diagnoses disease by concussion; the sphygmograph, for recording the character of the movements of the pulse, constructed by K. T. W. Ludwig (1816) in 1847, several forms of which are now in use—that most generally employed was first described by Marey in 1863—these and other instruments enable practitioners to locate and determine the conditions of interior organs with an accuracy undreamed of a hundred years ago.

The microscope is now employed to decide the exact character of diseased tissues, excretions, and sputa, and very recent mechanical additions have given to physicians an almost supernatural ability in diagnosis. A hundred years ago scores of conditions were profound mysteries to the most skillful practitioner, that are now perfectly intel-

ligible by means of the modern microscope and its attachments.

Can anything be sadder than the condition of the insane a hundred years ago? Says Dr. Cyrus Edson (New York Independent, October 7, 1897), even twenty-five years ago, "it was considered that a model insane asylum should consist of a vast block of buildings, the center of which was appropriated to the residence of the officers, kitchen, etc., from which there radiated long galleries in which small rooms, or cells, were arranged upon one or both sides of a corridor. At one extremity there would be public rooms, in which the agitated or non-industrial inmates, as the case might be, spent the day, while the more tractable patients were withdrawn to engage in some pursuit in workshops, or on the grounds, which were surrounded by high walls. A gradual but great revolution has taken place in regard to how the insane should be housed and treated. Asylums at the present time, especially those for wealthy private patients, are arranged very much like ordinary dwelling houses. The cottage system, i. e., placing the dangerous cases in cottages in the vicinity of public asylums, where they can be actively treated as their condition may require, has been found to be a great improvement over the old method. In all insane asylums the semblance and much of the reality of coercion has been abolished; the influence of religion, occupation, education, recreation; the judicious application of moral impressions, and the exercise of rational kindness and discriminating discipline, have been superadded to mere medical treatment, and substituted for brute force, terror, and cruelty. More important still, a stricter supervision is maintained over insane asylums, both public and private, by the State. It is very much more difficult, if not impossible, to get a sane person in an insane asylum now than it was a generation ago, when such abuses were quite common." And Dr. Edson adds: "There has been a vast change in improving the general condition of the patient, and, consequently, there is a larger percentage of such unfortunates either cured or helped. In treating them medicinally we have a far wider range of drugs to choose from. The discovery of synthetical chemistry has immensely widened the therapeutic armament of the physician in the treatment of the insane. They were thought to be possessed by evil spirits; they were chained, often in darkness; they were beaten; they were starved; they were exhibited for money to a cruel, jeering rabble. Everything was done to make the home of the intrusive demon undesirable. These severities aggravated the evils they ignorantly sought to remedy. An English parliamentary inquiry in 1815 produced a deep impression on the public mind, and fostered the belief that mental disease called for tender and indulgent treatment. In twenty-five years more that belief so strengthened that mechanical restraints were abolished. The professional keepers of the insane defended the methods of government

in which they had been trained, and scorned, as the dream of inexperience, the suggestion that madmen could be ruled by kindness. But the barbarous appliances of chains, and

PHILIPPE PINEL.

strait waistcoats, and chairs of restraint have been cast out of our asylums, and the reign of gentle and reasonable treatment inaugurated. Insanity, as it once existed, has undergone modifications. The very types of the disease have changed. Its unhappy victims, no longer exasperated by continual severity, have ceased to be afflicted by the demoniac frenzies which had rendered them so terrible, and have gained a gentleness and submissiveness to which they once were strangers."

In 1784 Benjamin Rush, of this country, first suggested humane care of the insane, but one of the brightest of the sons of genius devoted his life to this class of unfortunates. Philippe Pinel (1745-1826) came upon the stage when the profoundest ignorance prevailed, even among medical men, as to the treatment of those whose reason was obscured or deranged. One learned writer wished for machinery by which patients just arrived at an asylum, and after being drawn with frightful dangers over a metal bridge across a moat, could be suddenly raised to the top of a tower and as suddenly lowered into a dark and subterranean cavern; and he owned that if they could be made to alight among snakes and serpents it would be still better.

Pinel reached the sane conclusion that with kindness, firmness, patience, and by never exciting his patient, he could control and subdue him. His first experiment was with an English captain, who for forty years had been chained in a cell in the Bicêtre. His paroxysms of madness were most violent, and he had even killed one of his keepers with his manacles. Yet Pinel never for one moment doubted as to its being judicious to allow his chains

SIR RICHARD OWEN.

to be taken off. Approaching the unhappy creature, he said to him, "Captain, I will order your chains to be taken off and give you liberty to walk in the court, if you will

promise me to behave well and injure no one."

As might be imagined, the man was considerably surprised, and his answer was by no means unnatural.

"Yes, I promise you; but you are laughing at me. You are all too afraid to touch me."

"I have six persons ready to enforce my commands, if necessary," answered Pinel. "Believe me, then, on my word. I will give you your liberty if you will put on this strait-waistcoat."

The man readily submitted, and, his chains being removed, he was left to do as he pleased. For the first quarter of an hour, owing to the stiffness of his limbs from his long and close imprisonment, he could hardly rise from his seat. But at length he gained both strength and courage, and leaving his cell walked up the staircase, gazing at the sky, and uttering the expression, "How beautiful."

For the rest of the day he walked about in evident enjoyment, and quite free from the least sign of approaching irritation. In the evening he returned of his own accord to rest, and, for the first time, a comfortable bed being prepared for him, he fell tranquilly to sleep.

A few days after this Pinel released fifty-three patients from their chains and cells. What was most remarkable, as showing the accuracy of his judgment and his sympathetic power of discovering the moral and physical condition of his patients, was, that the violent lunatic whom he had first released, and who before that time was considered to be most dangerous, was of the greatest use to the institution in persuading his unhappy brethren in misfortune to so quietly conduct themselves as to gain the approval of the doctor, and so gain a further share of liberty.

His great learning is illustrated in the books he published on his chosen task; his serene wisdom and kindness were shown in his treatment of his patients, and his success in this field where he had no rivals, soon established in the world the germ of that wise, humane and successful treatment of the insane that now prevails in most civilized lands. Philippe Pinel was the pioneer in that field, and his name should be enrolled among the heroes of the Nineteenth Century.

At the death of Pinel, J. E. D. Esquirol (1772-1840) took up the work, and insanity was henceforth treated scientifically and successfully.

In the same year in which Pinel began his noble work in France, William Tuke initiated a similar one in England. Fittingly he called his little asylum "The Retreat." In 1815 a member of Parliament characterized the insane asylums of England as the shame of the nation. Up to the middle of the century long rows of patients were chained to the wall, and they were treated more like wild animals than like human beings.

The earliest of those who explored the brain, and reached the beginning of the proper treatment of the obscure diseases of the nervous system, was Doctor Franz Joseph Gall, in 1808. Following him came Louis A. Desmoulins, whose great book

appeared in 1825. Sir Charles Bell had already (1811) made great discoveries relating to the functions of the nerves. In 1823 Francois Magendie, and later Marshall Hall (1832), Theodor Schwann, Heile, Müller, Blande Bernard (1851), Brown-Séquard, Hermann Helmholtz (1852), Gustav Fechner (1860), Wilhelm Wundt, Herbert Spencer, M. J. P. Flourens, Cajal (1889), and a small army of experimenters and generalizers had wonderfully increased the knowledge of experimental psychology, and qualified the practitioner to treat the obscurest of all diseases. The century's progress is related in detail by Henry Smith Williams, M. D., in Harper's New Monthly, September, 1899. Bichat, in France, had already in the very beginning of the century, published his epochal works on "Membranes" and "General Anatomy."

Mrs. E. P. W. Packard (1816-189—), of Illinois, deserves mention for her services in behalf of the insane. Incarcerated in an asylum in Illinois, unjustly, as she claimed, she devoted herself after her release to ameliorating the condition of the insane. She visited every state in the Union, and appealed to each legislative body and secured laws allowing the inmates to write unopened letters, etc., and to institute commissions of inquiry so that those unjustly incarcerated might be released. Her personal efforts procured the amelioration of the condition of the insane in nearly every state in the American union.

The multiplication of specialists adds immensely to the efficiency of medical practice. Those who devote themselves to a special disease, and concentrate all available knowledge and all their time and ability to one ailment, are far more efficient than the general practitioner can be, especially in obscure and difficult cases, and the eye, the ear, the throat, the lungs, the brain, and other organs are treated with a skill and success that were impossible a hundred years ago.

The rapid growth of knowledge which has taken place, particularly during the last thirty years, made specialization inevitable. In the last century medical and surgery cases were mingled together in the same hospital wards, and surgeons like John Hunter (1728-1793) and John Abernethy (1764-1831) treated diseases of the heart and stomach as well as wounds and fractures. Sir Richard Owen, the eminent English anatomist, was one of the noted contributors to the century's advance in surgery. Nowadays it would be simply impossible for any man, however gifted, to take all medical learning to be his province. Hence one practitioner gives himself to the study of diseases of the nerves, others to the affections of the eye, the throat, the skin, and so on. Moreover, there are few physicians or surgeons who are not more or less acknowledged specialists in some particular class of diseases.

Then consumption was regarded as a visitation from God, impossible of cure. Now that its contagious character and origin in a bacillus are known, multitudes are cured

1. Phillips Brooks. 2. Edward E. Hale. 3. Charles H. Spurgeon.
4. Pope Leo XIII. 5. Marquis de Lafayette.
6. Louis J. Daguerre. 7. Professor Schlieman. 8. Wendell Phillips.

1. George Sand. 2. Florence Marryat. 3. Jean Ingelow.
4. Louise De la Rame. 5. Mrs. Margaret Oliphant.
6. Dinah M. Mulock. 7. Mrs. Humphrey Ward. 8. Mrs. Lynn Lynton.

while the disease is in its incipiency. The discovery of the infection in expectorations, and of the restoration attainable by change of climate, open air, sunlight, bathing and nourishing food, and of relying upon nature rather than medicine, is curing thousands who fifty years since would have been given over to death as hopeless. In fact, life is prolonged and rendered comfortable to multitudes who once would have surrendered long before.

More progress has been made in the prevention than in the treatment of disease. Sanitation and hygiene have done more than physic. Sanitary science was practically unknown fifty years since.

The synthetical drugs, the coal tar preparations, transfusion of blood, the hypodermic syringe, the use of antitoxin in diphtheria, the great addition of the new remedies that modern investigators have discovered, the disinfecting agents that ward off and counteract contagion, are wonderful factors in the extirpation of disease. Who does not remember the treatment received by the victim of fever, even a few years ago, from the most skillful practitioner? Blood-letting was compelled by leeches, lance, or capping; mercury was administered in great masses, and the patient, tormented with thirst, only survived as his constitution enabled him to endure the blows of disease and doctor. Now, little medicine, careful nursing, cooling drinks have substituted comparative comfort for torment, and the chances of recovery from fever are enhanced a hundred fold.

Neurology has made vast progress under the lead of Bell, Marshall, Hall, Abercrombie, Hughlings, Jackson, Reynolds, Gowers, Ferrier, Bastian, Buzzard, etc.

The discovery of vaccination ought to be credited to this century, for Edward Jenner (1749-1823) published his first memoir only three years before it began, in 1798. Hearing a young woman say that she could not take the small-pox, as she had had the cow-pox, he found on inquiry that an eruption on the udder of a cow would infect a milker, and secure immunity from small-pox. He inoculated several persons from a cow, and took the matter produced in human vesicles, and inoculated others. He subsequently inoculated for small-pox those he had vaccinated for cow-pox. Thus he discovered that vaccination secured against small-pox. The discovery is one of the greatest of medical discoveries, for which Parliament voted Jenner $50,000.

Many have fulminated against vaccination, but opposition is powerless in presence of the facts. As this work is being printed Alfred R. Wallace devotes 112 pages of his able work, "The Great Century," to the task of showing how much better off the century would have been without vaccination! In 1783 more than 4,000 children died of small-pox in Berlin; while in 1814, only 535 died of this disease. In London, where once the disease was so fatal, in 1890 there was but one death from it. Faces pitted with the disease were seen everywhere. Now they are rarely met. A celebrated English

physician declared "Jenner has saved, is now saving, and will continue to save in all coming ages, more lives in one generation than were destroyed in all the wars of Napoleon."

In Sweden, before 1802, before vaccination, there were 2,045 deaths to the million; from 1802 to 1816, 480; after that, under compulsory vaccination, 155; from 1884 to 1894, only two to the million. The British Insurance companies have decided that they cannot afford to serve, at regular prices, people who willfully invite epidemics, and that all who are not vaccinated must either increase their dues materially or not be insured.

One hundred years ago, blank incredulity would have met the statement that in 1897 small-pox would be virtually abolished, it finding a recrudescence only in communities of densely ignorant or more densely obstinate unbelievers in the virtue of vaccination. At the beginning of the century one-tenth of all deaths were from small-pox. Continually intermittent fevers destroyed many lives, and pressed heavily on the vitality of the rural population. In the cities, the filth of the streets and of the dwellings of the poor produced undue mortality. Epidemics were frequent and desolating. Medical science, whose era of progress was yet in the future, could do little to limit the ravages of disease. But yet the sanitary condition of the people was better than that of their fathers had been. The average duration of human life was steadily lengthening. Especially marked was the economy of life among the young, on whose immature strength the evil sanitary conditions of the time pressed most severely. At the beginning of the century, the deaths in London exceeded the births, and the growth of the metropolis depended wholly on immigration from the provinces. After 1810 these conditions were reversed, and the births exceeded the deaths.

The filthiness of ordinary life in England formerly is scarcely believeable, and it explains the dreadful plagues and mortality that wasted the people. Erasmus, who visited England, says: "If I entered into a chamber which had been uninhabited for months, I was immediately seized with the fever." As late as Queen Elizabeth's day the royal presence chamber was carpeted with hay. There was much improvement by the beginning of the century, but sanitary laws were practically disregarded and unknown. In fact systematic attention to the laws of hygiene, even in England, was not given until 1838. In 1837 and 1838, 14,000 out of 77,000 paupers in London were suffering from fever, 6,000 from typhus. Edwin Chadwick deserves the gratitude of mankind for his devoted services against bitterest opposition. Beginning in 1848, he continued his efforts for more than forty years, until the mortality was reduced to eighteen in a thousand. In the middle of last century it was eighty. The public health act was passed in 1875, and the death rate decreased one-half. Understanding and enforcing sanitary laws have wonderfully added to human health and longevity in such en-

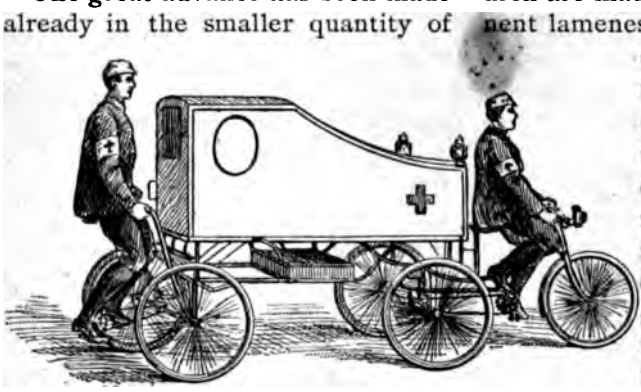
lightened countries as Germany, France, Great Britain and America. In England in the eighteenth century the average length of life was twenty-three years and eight months. Since 1864, thirty-seven years and six months.

The silent progress of civilized nations in sanitary matters is almost overlooked by most people. In England in 1800 the death rate was one in forty-eight. In 1810 it was one in fifty-one. In 1830 it was one in fifty-four. Says Professor Robert Mackenzie, in his "Nineteenth Century": A Parliamentary commission in 1842 reported that "the supply of water in cities was exceedingly defective, and so habitually impregnated with impure matter as to become poisonous. Houses were crowded without regard to decency or safety, and ventilation was unknown. There was no drainage. In Liverpool and Manchester one-eighth of the population lived in cellars almost without light, and seldom dry. The dead were buried in crowded city graveyards, poisoning the air of the neighborhood, and fatally tainting the wells from which the people had to drink. There were 43,000 pauper widows in England, and the commissioners were satisfied that in a great majority of instances the husbands of these poor women had been destroyed by causes which were easily removable. Filth and bad ventilation cost England more lives annually than she had lost by death in battle or by wounds during the bloodiest year of her history. It was possible to reduce by more than one-half the amount of sickness constantly existing in the country. The average length of life among the gentry and professional men of London was then forty-four years; in the laboring class it was twenty-two years. Of the three score and ten years of life to which the working man might reasonably aspire, two-thirds were sacrificed to the unhappy conditions under which his life was passed. The annual waste of adult life from causes which ought to be removed, was estimated at from 30,000 to 40,000." The enquiry resulted in measures that produced a higher physical condition of city populations, in comparative freedom from epidemic diseases, and in the increased duration of human life, as reported by the gradual fall in the death rate, which, in 1837, was 24.7 per 1,000, and in 1886 only 20. Excepting Sweden and Denmark, England is the healthiest of European states. The death rate of Italy is 28.7; of Austria, 29.4; of Hungary, 37.2; of Prussia, 25.4. France approaches England in the sanitary scale; her death rate is 22.7 per 1,000.

The greatest triumphs of all, however, in the realm of medicine have been achieved in the prevention of disease and the maintenance of a high standard of public health. The insanitary darkness with the result that typhus fever, which used to be a scourge of large towns, is now practically unknown; the mortality from "fevers" in general has been very greatly reduced; cholera has for a long time been prevented from gaining a footing; consumption is being brought more and more under

control; several years have been added to the average of human life, and it is not only longer, but more profitable and effective.

One great advance has been made already in the smaller quantity of medicine administered, and in the palatable form in which nauseous preparations are disguised. The "tablets" taken from the vest pocket are as far in advance of the disgusting mass taken from the old timer's saddle bags, as is their efficacy over their predecessors.



A RECENT STYLE OF AMBULANCE.

"The microscope, as it is now used, enables the practitioner to comprehend the exquisitely delicate organization with which he deals. The rejection of remedies applied in ignorance and the adoption of effective methods of treatment have naturally accompanied this large increase of knowledge. The use of chloroform and other anæsthetics has relieved humanity from the unutterable anguish, which, until thirty years ago, attended all important surgical operations. (See "Anæsthesia.")

The adoption of lithotrity has nearly abolished the nameless horrors of lithotomy. Aneurism is arrested in its deadly course by a devise so simple as the continued pressure of the finger upon seat of disease. The contorted limbs of children are made straight, and permanent lameness averted by the touch of the surgeon's knife, relieving the undue tension of a tendon. But in nothing are results of increased knowledge more acceptable than in the altered methods of treatment which surgeons now adopt. Middle aged and elderly people remark a striking diminution in the number of mutilated persons who are to be seen in our streets. From of old the surgeon applied the knife with a readiness which we now recognize to have been as mistaken as it was lamentable. The reign of conservative surgery is of recent origin, but it is firmly established. Amputation, it has long been said, is the opprobrium of surgery. The careful sur-

A HOSPITAL AMBULANCE.

geon has delivered his art from the opprobrium of needless amputation. He extirpates the offending shoulder, or elbow, or knee joint, leaving to its possessor the stiffened but otherwise serviceable limb."

Says the New England Medical Monthly: "Medicine is being rewritten, having for the foundation stones of its Æsculapean Temple, surgery and sanitary science, and it is safe to assert that a large class of diseases, which now reap their great harvest, are preventable, and that coming generations will profit still more from the discoveries of the last two decades in the limitation and control, if not the eradication, of many diseases, which, only a brief time in the past, were considered as a part of the providential part of creation."

Among the minor medical discoveries is one by Doctor Frank Reilly, of Chicago, who in August, 1895, suggested glycerinated lymph in vaccination. Since then (December, 1897) 276,000 vaccinations have been performed with it. Doctor Garrett, the vaccinator of the department, says of it: "I have noted in using this glycerine lymph a diminution of the usual inflammation surrounding the vaccine-vesicle; less fever and constitutional disturbance; entire freedom from abscesses, ulcers, swollen glands, and inflamed lymph vessels. The dreaded 'sore arm' of vaccination is a thing of the past. The use of the liquid lymph has revolutionized the practice of vaccination in this city, and it is due to this that our population is now the best protected against small-pox of any in the country."

Notable discoveries in the year 1897 are Maravigiliano's anti-tubercular serum, and Dursaud's microphonograph, the object of which is to make the deaf and dumb hear. It is also a notable fact that a company has recently been formed for the purpose of curing disease by blood infusion. The discovery of the various antitoxines, as the curative serums are called, which act as antidotes of various diseases, are among the most astonishing triumphs of medical science during the century.

It seems strange that all the ingenuity of surgeons and physicians had not achieved so simple a contrivance, and one that is now so essential as the stomach pump, until the year 1819. It is an achievement of the Nineteenth Century. The inventor was John Reed, in England. He thus describes the manner in which it was first used:

"After visiting London twice for the purpose of getting some suitable tubes, and failing, I made a third visit, and succeeded in getting an indifferent one, which I thought might answer, and then, after adapting it to the pump, I handed it to Sir Astley Cooper, who asked me for what purpose it was intended. I told him it was intended for the removal of fluid poisons from the human stomach; after a few minutes' inspection of the instrument Sir Astley made the following reply: 'About three weeks ago I was called to attend a young lady, about ten o'clock in the morning, who had taken opium. I gave her sulphate of copper, sulphate of zinc, and other things; I sat by her until eight in

the evening, when she died. If I had been in the possession of this instrument at the time, I could have relieved her in five minutes, and have saved her life.' After many questions how I came to think of such a thing, which I satisfactorily explained, he said: 'What can I do for you?' My answer was: 'The publicity of your opinion is all I wish.' He replied: 'That you shall soon have;' and he ordered me to meet him the next day at Guy's hospital, at one o'clock, when he proposed to try the experiment on a dog; but as no dog could be procured that day, Sir Astley proposed Friday at the same hour, when I attended as before; the dog was then ready for the experiment in the operating theatre, which was crowded to excess. The dog was brought to Sir Astley, who gave him four drachms of opium dissolved in water. The dog's pulse was first at 120; in seven minutes it fell to 110, and from that to ninety. The poison was suffered to remain in the dog's stomach thirty-three minutes, till he appeared to be dead, and I was doubtful it would be the case before Sir Astley would let me use the pump. I must confess I was very impatient to be at work on the dog, with my instrument in hand ready for action. Sir Astley kept his finger on the dog's pulse, then at ninety, and said very deliberately: 'I think it will do now, as it is thirty-three minutes since I gave him the dose.' A basin of warm water being then brought, Sir Astley passed the tube I had provided into the dog's stomach. I immediately pumped the whole contents of the basin (the warm water) into the stomach, containing the laudanum, back again into the basin. Sir Astley observed, while I was emptying the dog's stomach, the laudanum swimming on the surface, and said: 'It will do.' A second basin of water was then injected and withdrawn by the pump as before. I asked for a third, but Sir Astley said it was unnecessary, as the laudanum had all been returned in the first basin. In half an hour the animal was completely revived and running about the theatre."

Rudolph Virchow (1821) is one of the greatest medical discoverers of this or any other age. Though famous before most of the physicians of today were born, he has gone steadily on for the last half century adding to scientific knowledge of the human body, and now (1899), in his seventy-ninth year, is as hale and active as at the beginning of his career. Virchow's greatest discovery was that of the cellular nature of animal tissue, and it was his book, entitled "Cellular Pathologie" that formed the foundation for his world-wide fame. His theory was that the cell was possessed of an independent life, and that it was self-propagating. Taking the place of the former vague pseudo-philosophical views of vitality, this theory formed the basis for a new science of physiology. Since this great achievement, Virchow has gone on steadily making discovery after discovery. He has never practiced medicine to any extent himself, having been instead the instructor of practitioners. He no doubt derived suggestions from

Schleiden and Schwann, etc. The foundation of a scientific pathology was laid by Virchow, who looked for the starting point of disease in a perverted activity of the living cells of which the organs and tissues of the body are composed. The most truthful, as it is the most striking, development of our knowledge of the causes of disease has been the discovery of the infinitesimal organisms which go up and down the world seeking whom they may devour. The "germ theory" of disease is now a body of established truths. This is one of the greatest of all the medical discoveries.

The physician, through improvement of physiological knowledge and continued research and experiment, has become more helpful. He has largely become the adviser of his clients as to the prevention of disease. He has ceased to starve his fever patient, and to prevent his refreshment by water; he no longer withdraws his blood, reducing his strength, or if it is ever done, it is in the most emergent case. In most cases he has abandoned the use of calomel, which was commonly administered in fevers, to the frequent detriment of the patient's general health, if at all to his temporary benefit. The physician no longer administers heroic doses, or very rarely. He has found it needless to exhibit his remedies in gross, drenching his patient with disgusting mixtures, but has found how to produce the results he desires by more concentrated forms, more influential though less overpowering. Even the mere discontinuance of drugs has sometimes led to cure, and there are some physical troubles which are frequently subject to a roused will. Reformed dietary habits, regulation and regularity of meals, temperance in food as well as in drink, tend to physical health; and attention to sanitary principles, and the effective execution of sanitary laws in our larger cities and towns, with the improvements in medical and surgical science, have tended to prolong the average of human life upon the earth.

Among the great names in medicine, besides those elsewhere mentioned, are John Abercrombie (1781-1844), H. C. Bastian (1837), Richard Bright (1789-1858), discoverer of "Bright's disease"; E. Brown-Sequard (1818), C. R. Agnew (1830-1888), A. Carlisle (1768-1840), B. C. Brodie (1783-1862), W. T. Brande (1788-1866), L. Spalding (1775-1821), E. Ray Lankester (1847), G. L. Bayle (1774-1816), S. L Dana (1795-1868), John Forbes (1787-1861), P. Frazer (1844), H. Holland (1788-1873), C. W. Hufeland (1762-1836), John Jeffries (1744-1819), Joseph Pancoast (1805-1882), E. Seguin (1812-1880), James Sims (1831), Andrew Ure (1778-1857), Forbes Winslow (1810-1874).

Surgery, save in its mechanical dependence upon anatomy, has been thoroughly reformed. In fact, under the lead of Lamarck, Cuvier and Bichat physiology itself has been reconstructed. Had the physicians attendant upon President Garfield known, that valuable life might have been prolonged. The skillful surgeon now knows how to prevent blood

poisoning from wounds. The use of new anæsthetics has relieved surgery of many horrors, and the skillful surgeon can safely do what once would have been thought as impossible as to raise the dead. The surgeon of to-day may be said to perform miracles compared with his predecessors of a hundred years ago.

American surgeons have discovered anæsthesia, ovariotomy, lithotrity, modern gynæcology, and have perfected apparatus for treating fractures by extension; reducing dislocations by manipulation; the treatment of diseases of the hip and spine; the ligation of large blood vessels; the removal of tumors; surgery of the brain, spinal cord, mouth, jaws, kidney, liver, and urinary organs.

Before 1833 the cause of itch was unknown. A Pole, F. Renucci by name, discovered that it was a minute insect under the skin.

In 1834, James Paget (1814), in England, discovered specks in dissecting a human subject, which Richard Owen (1804) detected with his microscope to be trichina. In 1847, Joseph Leidy found the cysts in pork, and ten years after K. G. F. R. Lenckart (1823) and Virchow demonstrated that the parasite gets into human bodies by eating infected pork. This discovery is one of the many triumphs of the microscope. Further discoveries of microscopic vegetable and animal parasites were made about the same time by C. G. Ehrenberg (1795-1876), F. G. J. Heule (1809-1885), St. Vincent, Albert Kölliker (1818), C. F. Schoenbein (1799-1868), and others. (See p. 311.)

The great discovery of the cell theory for all vegetable and animal structure, about 1838, established the fact that all living organisms start in simple cells, the same in shape in all, which are differentiated as structures become more complex, but that at the beginning are the same in all forms of life.

A great revolution in surgery was wrought in 1809, by a brilliant young American, Dr. Ephraim McDowell, who, in Kentucky, performed the first ovariotomy. What numberless lives have been saved by this American operation.

Another great revolution in surgery was accomplished by an American surgeon, Dr. Horatio R. Bigelow, who, in Boston, in 1878, perfected the operation of crushing a stone in the bladder—lithotrity—an American discovery that marked an epoch in the history of surgery.

Daniel Rutherford (1749-1819) discovered nitrogen.

In 1808 J. Nicolas de Corriscert Desmarets (1755-1821), Napoleon's physician, first practiced auscultation, or percussion, in 1808, by tapping on the chest to detect disease. It had not been used, though invented by the German, Avenbrugger, in 1760. It was not until 1815 that René Theodore Hyacinthe Laenner (1781-1810) began to listen, by a cylinder of paper or wood, and has established the modern method of discovering diseased conditions of the breast or lungs. This is the origin of the stethoscope, and is one of the great steps taken by medical science. In 1828 P. A. Piorry (1794-1879) (French), also suggested tap-

ping on the finger or other substance, laid on the chest. Early in the century Marshall Hall (1790-1857), in England, and Francois Magendie (1783-1855), in France, hastened the end of bleeding, so long practiced by medical men.

The introduction of anæsthesia by Sir J. Simpson (1811-1870) led to the improved surgical practice of Fergusson, James Syme (1799-1870), James Paget (1814), and others. Ovariotomy has saved hundreds of lives in the hands of Spencer Wells (1818), Bancock, Keith and Tait. Antiseptic treatment has been introduced by Lord Joseph Lister (1827), with equally great effect; and Pasteur's inoculation treatment has, it is believed, been carried to success, and will produce the grandest results in preventing disease. (See "Bacteriology.") The introduction of lithotrity, the cure of aneurism by pressure, the use of the ohpthalmoscope, laryngoscope, thermometer, endoscope, splanchnoscope, sphygmograph, etc., with the radical cure of hernia, skin-grafting, nerve stretching, etc., may be mentioned as among the comparatively recent triumphs of modern surgery, rendering operations less terrifying and much more effectual.

The sphygmograph tells and records every variation of the human pulse, the condition of the heart, shows the effects of drugs, etc., and tells, as no other investigation could show, the exact status of the internal mechanism. Invented by Chauveau and E. J. Marey (1830).

The spirograph traces the rise and fall of the chest.

One of the great benefactions of the century is the artificial leg, invented by Benjamin Franklin Palmer (1824), of Philadelphia. When a young man he lost a leg by accident, and, after much reflection how to supply the loss, on April 16, 1845, he cut down a willow tree, in the morning, shaped it that day, boiled it that night; further shaped it the next day; baked it the next night; put it together in a few days, walked upon it early in 1846, and sold the first one in June of that year. In the same year he secured patents—the first ever taken for an artificial leg, in this country, England and France. In 1864 he had 1,000 orders on file at once. He got bills through Congress giving limbs to the mutilated, and made tens of thousands of limbs. He took contracts to the amount of $1,100,000, on which he lost $1,000,000. He writes in 1897: "Fifty-one years gone into it and all I made gone out of it." It seems the frequent fate of great inventors to benefit mankind at their own expense and loss.

There are in the American Patent Office records of hundreds of patents for artificial limbs. Says the judge's report in the department of Prostesis, in the Centennial Exhibition, 1875:

"The Civil War, which caused the mutilation of multitudes of soldiers, and the noble liberality of the Government in making provision for supplying the mutilated with artificial limbs, naturally acted as powerful stimulants to the efforts of inventors to produce substitutes which should command the patronage of

the Government. The mass of these patents are either for crude and ill-considered devices, entirely unfitted to supply properly the want they were intended to meet, or for mere details of improvement on recognized inventions.

"First, both in time and importance, is the artificial limb of B. Frank Palmer, which was patented November 4, 1846, and improved by further patents in 1849 and 1852. This leg is more widely known, and has met with more general approval by the profession and the public, than any invention of its class. The American surgeons have vied with those of Europe in praise of its excellence. There is scarcely a name eminent in surgery in England, France, or the United States that is not on record as endorsing the merit of this admirable invention." Gross, in his great work on surgery, says: "It would be difficult to conceive of any apparatus more beautiful in its construction, or more admirably adapted to the end proposed, than the artificial substitutes of Mr. Palmer. Combining lightness with strength, and neatness with symmetry, they are worn with great comfort and satisfaction, and are apparently as perfect as any piece of human mechanism can be made, the whole arrangement being a close imitation of the natural muscles and tendons, if not in shape at least in position and function."

The Centennial Award says: "A production which embodies the intelligent effort of a life-time, and which affords the utmost compensation for one of the direst forms of human misfortune, entitles its author to a position in the front rank of the inventors and mechanics of the age."

Doctor O. W. Holmes wittily said: "The willow which furnishes the charcoal for the gunpowder that blows off the limbs, is the wood chosen to supply the loss it has helped to occasion. America has bestowed upon the world an anodyne which enables us to cut arms and legs off without hurting the patient; and when his leg is off, she has given you a true artist's limb for your cripple to walk upon, instead of the peg on which he has stumped from the days of Guy de Chauliac to those of M. Nelaton."

In December, 1897, Doctor Schlatter, in Zurich, Switzerland, removed the entire stomach of Miss Anna Landis, without loss of life. Doctor G. G. Van Schaick, one of New York's celebrated surgeons, referring to the case, said: "The advance in modern surgery has been very gradual, and has been largely due to two Americans, Doctors Murphy and Senn, of Chicago. Doctor Senn's skill and efforts made all such operations possible and all but anticipated Doctor Carl Schlatter in the operation which the Medical Record of New York characterized as epoch-making."

Doctor Senn successfully removed eight feet, almost one-fourth, of the intestinal tube, and sewed the two ends together, and the patient recovered completely, and another Chicago physician, Doctor Christian Fenger, has removed parts of the stomach.

According to the Chicago physicians, Doctor Schlatter has been an-

ticipated in his own city in this operation by Professor Kronleim, the pioneer in this field, who attempted it three or four times before Doctor Schlatter, and successfully in at least one instance.

The credit for all such operations is really due to Doctor Senn. He established a laboratory in a stable in Milwaukee and performed a large number of operations upon horses. The advanced treatment of wounds in the intestines by the use of hydrogen gas is an invention of Doctor Senn's. He shot horses in the abdomen and pumped in gas. If the gas escaped through the wound he knew that the intestine had been perforated. If not, it proved that it was unhurt. Doctor Senn has advanced intestinal surgery more than any physician in the world. No man in the world has brought out more new operations in intestinal surgery. He first used what is now known as Senn's decalcified bone plates in uniting severed sections of the intestinal tube. He practically invented and certainly perfected this operation.

The New York Medical Record says: "The feat itself is the most brilliant and daring ever attempted in recent surgical history, but the attendant discovery that the stomach is not a vital organ is even more important. Hitherto it has been considered utterly impossible for a person to live without a stomach. With the fall of this long recognized axiom the old theories of medicine and surgery may be entirely changed and the field of possibilities which the discovery opens up is practically limitless. Whatever we may venture pro or con on the question at issue, the fact appears to be proven that the human subject can live and be reasonably active for months at a time without any stomach whatever, and obtain all the necessary digestion and nourishment from what remains of the intestinal tract. Is it possible that the latter may have a new set of functions not yet understood, or has the importance of stomach digestion been misapprehended and overrated? In any event we are now brought face to face with a very curious demonstration which destroyed the vitality of many preconceived opinions and in a great measure nullifies the results of many previous experiments.

The extirpation of the womb is another of the incredible miracles of modern surgery. Nose and ears, jawbones, etc., have been replaced, and substitutes for noses have been made by using the breast-bone of the blackbird, and grafting skin over it.

Says Dennis in his "System of Surgery," pages 90-91: "The salient points in the history of surgery in the nineteenth century are the discovery of anæsthetics; the establishment of aseptic and antiseptic surgery upon the scientific foundation of the new science of bacteriology; the development of conservative surgery in the treatment of diseases of the extremities and of plastic and orthopædic surgery into a specialty; the rise and progress of abdominal and intracranial surgery; the great advances made in pathological anatomy and experimental pathology,

and the development of ophthalmology, otology, gynæcology, dermatology, and laryngology. . . . More progress in the art has been made since 1800 than had been made during the 2,000 years preceding that date. . . . The surgeon of 1800 had little more knowledge than had Hippocrates of the chief causes of danger after operations, such as suppuration, pyæmia, or tetanus, and groped wildly for means to avoid them. He had no clinical thermometer, and could only guess at temperature, and fever; no hypodermic syringe; no anæsthetic; no definite knowledge of the importance of blood saving, or of the best means of doing it. He knew nothing of plastic surgery; of tenotomy; of the ophthalmoscope, or of the use of the microscope in diagnosis, and had only just learned how to ligate arteries and to treat ordinary wounds in a simple and sensible way." Some 500 instruments and appliances are named in the "Mechanical Dictionary," most of them inventions of the century.

Among the great surgeons of the century, besides those already named, are Henry Cline (1750-1827) William Adams (1820), William Aitken (1825), William Blizard (1748-1835), Everard Home (1756-1832) P. E. M. Berthelot (1827), Andrew Clark (1826), John Bell (1796-1872), Astley Paston Cooper (1768-1841), William Lawrence (1783-1867), James Wardrop (1780-1869), Benjamin C. Brodie (1783-1862), Robert Liston (1794-1847), William Fergusson (1808-1877), especially famous for operations of hare-lip and cleft palate; James Symne (1800-1870), Guillaume Dupaytren (1778-1835), the most distinguished in the world of his day; J. F. Malgaigne (1806-1865). In Germany, Von Langenbeck (1818-1897), the most eminent German surgeon in the nineteenth century, whose operations relating to plastic surgery of the nose, and of the hard palate, removal of the tongue, etc., were marvelous for his times. Theodore Billroth (1829-1894), "first excised the larynx for cancer (1873), first successfully excised a large portion of the stomach (1881)," etc. In this country among the most celebrated have been John Warner (1753-1815), who extirpated the parotid gland in 1804; Phillip Syng Phisick, "the father of American surgery" (1768-1837); E. McDowell, who originated the operation of ovariotomy; H. B. Sands (1830-1888), who first operated in peritonitis cases, by perforation of the appendix; William Guthrie (See "Anæsthesia"), C. R. Agnew (1830-1888), Charles Bell (1774-1842), John Bell (1763-1820), A. V. Berlinghieri (1772-1826) (Italian), B. W. Dudley (1785-1870), R. D. Mussey (1780-1866), A. M. M. Ross (1832), Thomas Wakley (1795-1862), Jeffries Wyman (1814-1874).

Valentine Mott (1785-1849), when but thirty-three years old (in 1818), placed a ligature around the bracheocephalic trunk or arteria innominata, within two inches of the heart, for aneurism of the right subclavian artery. This was the first time this wonderful operation had ever been performed, and the skill and success with which he accomplished it

stamped him as one of the brightest lights of his profession. The patient survived the operation twenty-eight days, and thus demonstrated the feasibility of this hazardous and thus far unparalleled undertaking. He discovered in this case that, though all supply of blood to the blood-vessels of the right arm was apparently cut off, the circulation was kept up by the interosculating blood-vessels, the pulsation at the wrist maintained, and no evidence of loss of vitality or warmth manifested in the limb. The patient finally died from secondary hemorrhage. In 1828 he performed successfully the most difficult and dangerous operation known in surgery. A clergyman called upon him to remove an enormous tumor in the neck, in which were imbedded and twisted many of the great arteries. In this operation it became necessary to take out entire the right clavicle, or collar bone, to lay bare the membrane which surrounds the lungs, to search for and dissect around the arteries which ran through the tumor, to make forty ligatures, and to remove an immense mass of diseased matter. This terrible operation had never been attempted before, and was performed by Dr. Mott without the aid of chloroform; yet it was done so skillfully that the patient survived it, and in 1865 was still living and discharging his ministerial duties. It was thirty years before it was attempted again in any part of the world. It was a great triumph of the genius of the operator, and won him praises from men of science in all countries. In 1821 he performed the first operation for osteo-sarcoma of the lower jaw. In 1822 he introduced his original operation for immobility of the lower jaw. He was the first surgeon who removed the lower jaw for necrosis, and the first to tie successfully the primitive iliac artery for aneurism. Other of his original operations were cutting out two inches of the deep jugular vein, inseparably imbedded in a tumor, and tying both ends of the vein, and closing, with a fine ligature, wounds of large veins of a longitudinal or transverse kind, even where an olive-sliced piece had been cut out."

But to record all the names of the surgeons who have assisted in the progress of surgery would be to cover pages. Besides those named are Teale, Pirogoff, Carden, Gritti, Stokes, Jordan, Wells, Kobberte, Pean, Esmardi, Hutton, Bellingham, Tafnell, Carte, Vanzetti, Knight, Cameron, and Watson. The great benefactors in surgery during the century have been Morton, of Boston, who first actually produced blessed oblivion while a tumor was removed from the neck of a patient, and Lister, who learned and taught how to shut out the microbes of destruction from wounds, reducing mortality after operations from sixty-five to seven per cent.

Homeopathy: This modern school of medicine is wholly the product of this century. It aims at curing diseases by administering medicines which produce symptoms similar to those which they are designed to remove. The Latin dictum on the subject is "Similia similibus curantur." Its founder was Samuel

Hahnemann (1755-1843), born at Meissen, in Upper Saxony. In 1790, while investigating the operation of peruvian bark, in intermittent fevers, he found that a dose of the bark, which he took, produced in himself phenomena like those of the fever it was designed to combat. Pursuing his experiments, he believed that he had discovered a general law that like is cured by like, and in 1810 published his Organon of the healing art, in which he explained his system, calling it for the first time Homeopathy. The great majority of medical men reject the system, though it has many advocates.

Kinesipathy: The Movement Cure, or Massage, was originated by H. P. Ling (1776-1839).

Hydropathy: The Water Cure originated with a Silesian peasant, Joseph Priessnitz (1790-1851), who, having injured his leg, noticed that he reduced the inflammation by holding it under a pump. Priessnitz opened a cure in the village of Graefenburg. His idea was taken up by two doctors in Berlin, and from that city it spread to England and to France. The new system of treatment was introduced in America by two Boston doctors, but its great apostle in this country was Russell Thatcher Trall (1812-1877), who opened a hygienic college in New York City, connected with a boarding-house, in which he applied his peculiar notions about diet. He wrote two volumes on the subject, "Hydropathic Cyclopædia," and he graduated from his college men and women doctors, who scattered over the country to open new water cures. The water-cure was usually a large building pleasantly situated in the midst of lawns and groves, and the regime followed was beneficial to people who had spoiled their digestion. Copious douches, shower baths, sitz baths, tub baths, and wet-sheet packs soon cooled off the systems of these patients, and the simple diet given them aided in effecting a cure. One of the chief remedies of these institutions was what was called a wet-sheet pack. The sheet was dipped in water, and when wet was spread upon the bed, the patient was placed naked on top of it and the sheet was tucked in around him from neck to heels. Blankets were then piled on, and in the reaction which usually ensued, the patient broke out into a profuse perspiration. He could move neither head nor feet, and he had to submit to the pack for about an hour before he was released and washed off by the attendants. Dr. Trall allowed no meat to come upon the table of his hotel. He disapproved of the use of butter, milk, salt, pepper, and pretty much the whole range of good things in cookery, for which the average man longs. The bread, of course, was made of Graham flour, and the vegetables were served without any sort of seasoning. The last water-cure establishment to survive was one conducted by Dr. Jackson, at Dansville, New York. Dr. Jackson, however, did not go in much for the cold water treatment. He looked after the diet of his patients, gave them plenty of exercise and sun baths, and made of his "Home on the Hillside" a very comfortable,

social and attractive place. There is not now a single old-fashioned water-cure anywhere in the United States. In the year 1855 there must have been hundreds of them. In place of the water-cures there have now come the sanitariums, which enforce the hygienic rules first adopted by the hydropaths.

There has been an immense advance in recent years in the matter of bathing. Not many years ago bathtubs were almost unknown in the cities and country, and the only way of taking a bath was to go into the kitchen, where there was no carpet on the floor, get a bowl of water and wash yourself off. On Sunday mornings in the farmhouse the kitchen was reserved for the female members of the family, while the boys sought the nearest creek or milldam. E. V. Smalley writes, in the Chicago "Times-Herald:" "When my father, on his Ohio farm, became a convert to hydropathy, he converted an old smokehouse into a shower bath; but the process of being soused in cold water was so terrible to me that when my turn came the family used to have to organize a hunt in the currant bushes and the barn for the truant boy to bring him to his bath."

Osteopathy: Dr. A. T. Still, in the latter part of the century, discovered and founded the science of Osteopathy, which dispenses with drugs and medicines, and professes to cure most ailments by manipulation.

The London "Lancet" confirms the conclusion of the registrar general's statistics that during the past half century the so-called "middle arch of life" in England has advanced in age from about forty years to nearly fifty. Dr. W. Ainslie Hollis, who sums up the proofs that we age more slowly than did our forbears, says that this advancement of the middle arch of life means an enormous improvement in the health of the nation and a corresponding delay in the manifestations of senility.

As has been shown in Surgery, the introduction of anæsthesia improved surgical practice. Ovariotomy has saved hundreds of lives. Antiseptic treatment has been introduced with equally great effect; and Pasteur's inoculation treatment has been carried to success, and will produce the grandest results in preventing disease. The introduction of lithotrity, the cure of aneurism by pressure, the use of the ophthalmoscope, laryngoscope, thermometer, endoscope, splanchnoscope, sphygmograph, etc., with the radical cure for hernia, skin-grafting, nerve-stretching, etc., may be mentioned as among the comparatively recent triumphs of modern surgery, rendering operations less terrifying and much more effectual. In fact, such has been the progress of discovery and invention in Medicine and Surgery, that the prevention of disease, the saving of injured limbs, the preservation of vital organs, the prevention of pain, the duration of life, and operations that were absolutely impossible, even a few years since, are now almost at the command of the skillful practitioner.

"The characteristic of the modern school is the adoption in medicine of

the methods of research of physical science and the gradually declining importance attached to theory and abstract reasoning, — hypotheses, though not neglected, being used as a means of research rather than as ultimate conclusions. Its method may therefore be called the positive method, or that of rational empiricism."

The advancement of Medicine and Surgery during these passing years inspires the hope that they may make such progress in the twentieth century as to carry life and health up to the four score years of the Psalmist, and then that the average man's days may cease, not by the interference of disease, but by the execution of the statute of limitation.

WILLIAM T. G. MORTON.

[Born 1819. Died 1868.]

There is in the Public Garden of the City of Boston a beautiful monument, dedicated to and perpetuating the discovery of ether as an anæsthetic. It is a superb memorial of the skill of the sculptor Ward. Public opinion will, we think, sustain us in the wish to see an important omission supplied by placing thereon the name of the discoverer, William Thomas Green Morton. The monument will then be complete.

CHAPTER XXII.

ANÆSTHESIA.

ETHER — CHLOROFORM — GUTHRIE — WELLS — MORTON — JACKSON — SURGICAL OPERATIONS RENDERED PAINLESS—COCAINE—CHLORAL, ETC.—ALL NINETEENTH CENTURY DISCOVERIES.

ONE of the most ancient of the theories of medical men was the opinion that there must be an agent that could produce insensibility to pain; but it was not found until within the "Century of Centuries." Its discovery changed surgery from a cruel to a painless art. Says a medical writer: "Of the horrors of operations before the discovery of anæsthesia, there are men still living who can speak. Not long ago Dr. E. B. Cotting, ex-president of the Massachusetts Medical Society, contributed some personal reminiscences of pre-anæsthetic surgery to the Boston Medical and Surgical Journal. Speaking of the first case in which he was called upon to use the knife, in the year 1833, he says: 'Our patient (a woman) writhed beyond the restraining power of strong and experienced men, and groaned to the horror of the terrified household, and afterward to the day of her death could not think of the operation without convulsive shudders. Often did she hold up her hands, exclaiming, "Oh, that knife! that awful knife! that horrible knife!"' Dr. Cotting sums up his recollections of such scenes as follows: 'No mortal man can ever describe the agony of the whole thing from beginning to end, culminating in the operation itself, with its terrifying expressions of infernal suffering.' The pain caused by operations prevented their being undertaken except as a last resource, and many patients preferred death to the surgeon's knife."

Without anæsthesia the marvelous victories of the knife, on which modern surgeons legitimately pride themselves, would have been impossible. Nor is it surgery alone that has been revolutionized by this splendid discovery; medicine, therapeutics, pathology, and physiology —which are the foundations on which the treatment of disease rests —have all been immensely advanced by it, as without anæsthesia the experiments on animals, to which we owe much of the knowledge that has been acquired, could not possibly have been carried out.

Surgeons were formerly experimenting in the dark, compared with the intelligence with which they now operate. Dexterity and speed were then essential. Amputation of the thigh was done in two minutes. Now, thanks to anæsthesia, careful deliberation and perfect safety can be secured. No other discovery in

medical science equals this in preventing human suffering. When Sir Humphry Davy was in his twenty-first year (in 1800) he had a hint of this most important of all the contributions of medical science to man's happiness. He said of nitrous oxide, or "laughing gas," after having a tooth painlessly extracted under its effects, "As nitrous acid gas seems capable of destroying pain, it could probably be used with advantage in surgical operations where there is no effusion of blood." But his suggestion was only conjectural, and had no practical results.

In 1818 Faraday showed the resemblance between ether and nitrous oxide, but they were still used in amusing experiments only. Hickman, a London surgeon, in 1828 wrote that he had discovered a means of performing the most troublesome operations without pain by introducing certain gases into the lungs.

"Laughing gas" was only a source of amusement in medical schools up to this time. This writer, with schoolmates, indulged in it in Lowell, Mass., in 1837. J. C. Ayer, of Cherry Pectoral fame, G. V. Fox, afterward Assistant Secretary of the Navy during the Civil War, and Gen. B. F. Butler, of national reputation, were his companions.

In January, 1832, an article appeared in Benjamin Silliman's (1779-1864) American Journal of Science and Art, by Dr. Samuel Guthrie (1782-1848), of Sackett's Harbor, N. Y., dated September 12, 1831, in which he describes "a bottle and phial containing alcoholic solution of chloric ether," and in the October number of 1831 is an article on, "a new mode of preparing a spirituous solution of chloric ether," in which Dr. Guthrie says: "During the last six months a great number of persons have drunk of the solution of chloric ether, not only freely, but frequently to the point of intoxication." As the magazine contained a notice that communications must be in the printer's hands six weeks before publication, it follows that the article must have been written as early as August, 1831, and as Dr. Guthrie says, that the preparation had been tested for six months, Dr. Guthrie's discovery must have been as early as February or March, 1831.

The contestants to priority over Guthrie, in discovering chloroform, are the great Justus Liebig (1803-1873), and the famous Frenchman, Eugene Soubeiran (1797-1858). But Liebig did not publish his alleged discovery "*chlorkohlenstuff*," until November, 1831 (Liebig's *Annalen* vol. 162, p. 161), and Soubeiran, who claims to have published his discovery on *ether bichlorique* in October, 1831, is shown by Liebig not to have published it until January, 1832, as the magazine (*Annals de Chimie et de Phisique*) did not appear until January, 1832. Reviewing these facts, the "Chicago Medical Society, in February, 1886, voted that "Dr. Samuel Guthrie is justly entitled to the honor of first discovering chloroform." The United States Dispensary says: "Chloroform was discovered by Dr. Samuel Guthrie, Sackett's Harbor, 1831." Dumas, in 1834, determined its chemical formula $CHCl_3$, and named it chloroform.

It is one of the curiosities of invention that the discoverer of the destroyer of pain, Guthrie, should also have invented percussion powder, one of the great agencies of war. In 1842, Dr. C. W. Long, of Athens, Georgia, produced anæsthesia with ether, and painlessly removed tumors, but a fatal result in the case of a consumptive caused him to abandon the practice.

In 1844, Horace Wells (1815-1848), a dentist in Hartford, Connecticut, attended a lecture by Cotton, in which the usual experiments were performed, with nitrous oxide gas. At his request the lecturer administered it to him in order to test it in tooth-pulling, and on emerging from his insensibility, wholly unconscious of pain, he cried: "A new era in tooth-pulling." He used the nitrous oxide for awhile, but the results were unsatisfactory, and he ceased from using it. In 1845 he met Dr. W. T. G. Morton (1819-1868), a Boston dentist, who had previously experimented on animals and on himself, and on the 30th of September, 1846, had made a man unconscious by breathing sulphuric ether, and extracted a tooth without the patient feeling any pain. On the 16th of October, of the same year, Morton administered ether in the Massachusetts General Hospital, to a man from whose neck a growth was excised without a groan or a struggle on his part, by Dr. J. C. Warren (1778-1856), who had suggested to Morton the use of sulphuric ether.

Dr. H. J. Bigelow, of Boston, read a paper, on November 3, 1846, which was printed in the Boston Medical and Surgical Journal, of November 18, 1846, entitled, "Insensibility during surgical operations produced by inhalation." In 1847 Morton used chloroform for the first time. Dr. Liston, the eminent surgeon, in December, 1846, amputated a thigh, and proved that ether was a perfect anæsthetic, and from this time on it was employed in dental and surgical operations. About the same time Dr. Charles T. Jackson (1805-1880) employed chloroform, and claimed its original discovery. But as is shown fully in the preceding pages, the first to use chloroform—the original manufacturer—was Dr. Guthrie, in 1836, and the first to use it as an anæsthetic was Dr. Morton, in 1847. Dr. Long used ether in 1842, and Horace Wells in 1844.

In 1847 Sir James Y. Simpson (1811-1870), of Edinburgh, and his assistants, Drs. George Keith and Matthews Duncan, on the evening of November 4th, inhaled the fumes, and Simpson says, "were all under the mahogany in a trice, to my wife's great consternation and alarm." Sir James used chloroform extensively, especially in obstetrics, but it was soon abandoned on account of its danger.

It is claimed by many that the first use of chloroform in surgery was by Sir J. Y. Simpson, in Edinburgh, and that it was suggested to him by Waldie, of Liverpool. Dr. Simpson tested its efficacy, and thence onward it superseded ether, as more rapid and certain in its effects, and pleasanter to the taste. Dr. Simpson used ether at first, and until chloroform was brought to his notice.

In January, 1848, its application produced fatal results, and since then ether and chloroform are used, with the general preference for ether. Dr. Simpson welcomed chloroform as a most valuable acquisition for the medical art, and introduced it into universal application; in obstetrics, as Dr. Holmes says, "abolishing the primal curse on woman." Lander Brunton says: "Ether is a blunt knife; chloroform is a sharp knife." Dr. Simpson was bitterly opposed by the "unco gude," in Scotland, on the ground that chloroform in obstetrics avoided "one part of the primal curse on woman." Sir James appealed to Genesis ii, 21, where God caused a deep sleep to fall on Adam before he extracted his rib. But opposition soon ceased, and the inscription on the Boston monument to the discovery of anæsthesia records the verdict of the world, "This also cometh from the Lord of hosts, which is wonderful in counsel and excellent in working." In awarding the prize for the discovery of anæsthetics the French Academy gave one-half each of 5,000 francs to Morton and Jackson.

Dr. O. W. Holmes declared that the abolition of all the medical agents but chloroform and quinine would be a benefit to the world. Dr. Holmes named the new process Anæsthesia.

A great controversy arose over the respective merits of chloroform and ether, and the claims of Morton and Jackson. Dr. Holmes parodied the lines of Moore, when asked his opinion:

"How happy could I be with ether
Were 'tother dear charmer away."

Says Lewis H. Watson, M. D., Chicago, in the "New England Medical Monthly" for November, 1897:

"Just fifty years ago, in the amphitheatre of the Massachusetts General hospital, a young man was laid upon the operating table, and while under the influence of ether, administered by Doctor Morton, Doctor John C. Warren removed a tumor from his neck without pain or consciousness. Nothing so wonderful as this had been known in the world of medicine and surgery since Homer sang of Æsculapius's art, and great Jupiter—whose sign we daily use—resenting the god of Medicine's interference in bringing back Hippolytes to life, destroyed him with a bolt.

"What pæans of praise should we poor mortals not have sung to think that pain was banished from our lives when under the surgeon's knife? What honors should not have been conferred upon Morton, Wells and Jackson, and yet—and yet—these men all died in obscurity and want. From that day to this the misery and anguish which had heretofore racked the human frame were no longer known. The muscular strength of man and the delicate, shrinking tissues of woman, were never more to be called upon to endure the ordeal of the knife. With the sufferer deprived of consciousness, the work was half accomplished. We have the recorded statements of the surgeons of those days, of the mental strain and dread

with which they approached their self-imposed task. A well-known physician, who suffered the amputation of a leg, just before the reign of anæsthesia, has given a touching picture of the horror and despair which seized him when his brother physicians gathered around the operating table, upon which he lay bound; and the excruciating agony he felt when that cold steel was passed through his thigh. I have seen the most delicate woman, with the highest emotional temperament, go smiling to the operating room, from which she emerged with a new lease of life, uttering a benediction upon the discoverers of anæsthesia. The little child, the aged man, lie down and sleep until the surgeon calls them back to life and health. All this has anæsthesia done. Marvelous, indeed, as a beneficent gift bestowed by man's genius upon man."

The Massachusetts Medical Society memorialized the Legislature in these words:

"The undersigned hereby testify to your honorable bodies that, in their opinion, William T. G. Morton first proved to the world that ether would produce insensibility to the pain of surgical operations, and that it could be used with safety. In their opinion, his fellow-men owe a debt to him for this knowledge." Jackson became deranged and died in an asylum, and Morton became ill, and neither derived financial benefit from their great discovery.

Cocaine, the active principle of cocoa leaves, was discovered by Niemann, in 1860, and soon began to be used to produce local anæsthesia. Whomsoever may be declared to be the real discoverer of anæsthetics, one fact is apparent: this great achievement in preventing human agony, is one of the most wonderful triumphs of the Nineteenth Century.

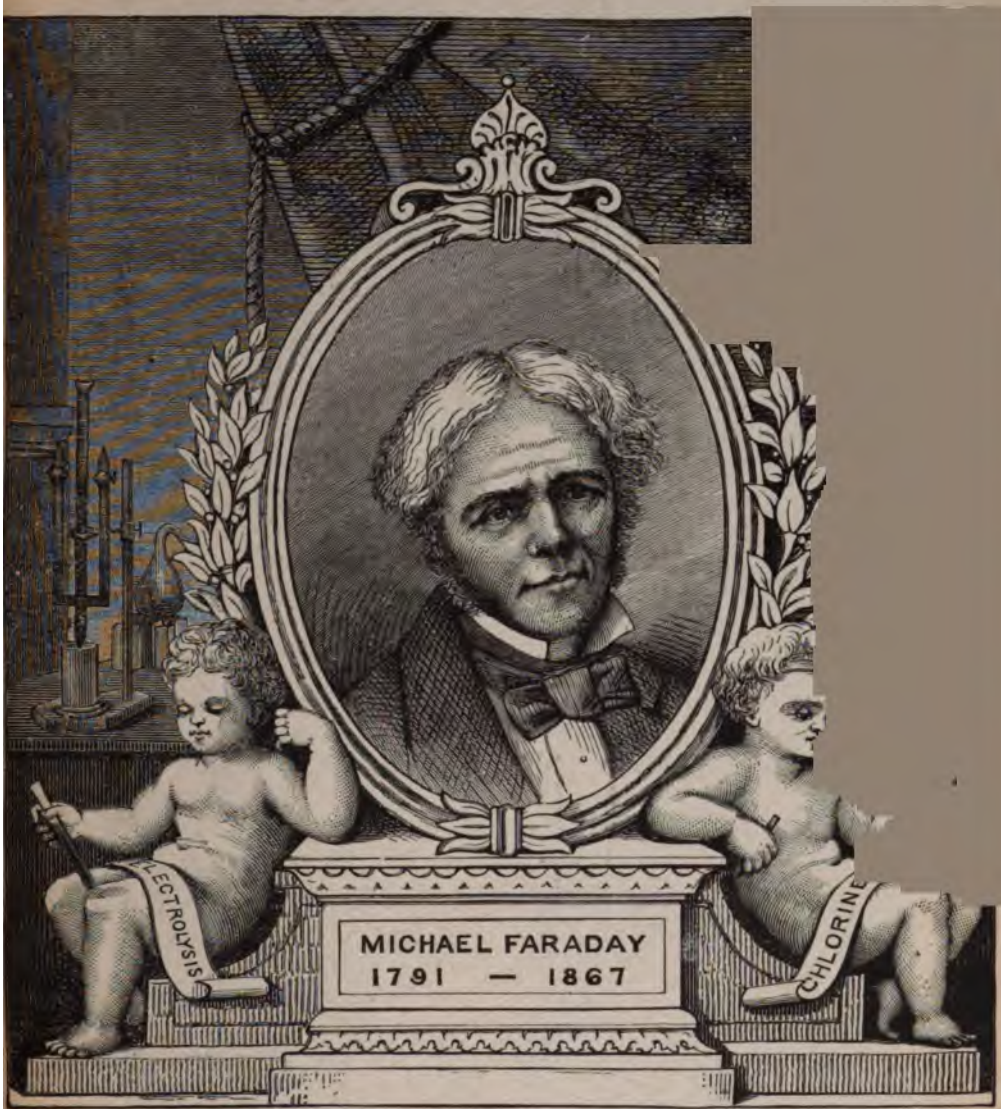
Several minor anæsthetics are in use, though none equals ether or chloroform. Such are bichloride of mettrylene, first recommended by Doctor B. W. Richardson (1828), in 1867; pental, said to be unsafe and injurious; ethyl bromide, proposed in 1849 by Doctor Thomas Nunnelly, though not much in use till 1876-7.

Local anæsthetics are orthoform, discovered by Doctors Eichorn and Heinz, of Munich, a preparation of benzomethrylic ether, in the form of a powder, which relieves at once the pain of deep burns, of ulcers and of cancers; cocaine, an invaluable agent for producing local insensibility, discovered in 1859, but not used until 1884, when Koller introduced it in Vienna; ether spray was first used for the same purpose by Doctor B. W. Richardson, in 1865; chloral (hydrate) was discovered by Doctor O. Liebrich. Eucaine is a new anæsthetic which renders any portion of the human body insensible to pain, where cocaine cannot be safely employed, while the patient remains perfectly conscious. Bromine was first produced by A. J. Balard (1802-1876), in 1826, from the salts of evaporated sea-water. Morphine was discovered by Serturner, in 1816, by decomposing extract of opium by chloride of barium.

The story of the advances of medical and surgical science reads like a fairy tale. The Nineteenth Century is the golden era of its progress. Its greatest achievement is the discovery of anæsthetics. The search is being pushed for new and safe anæsthetics, but if no more are found the Nineteenth Century will be ranked above all preceding centuries as much, at least, for the blessed dicovery, anæsthesia, as for its railroads and telegraphs, its steamships and telephones.

MICHAEL FARADAY.

[Born 1791. Died 1867.]



Not the least useful lesson in the life of this upright, noble-minded, and lovable man was the perfect union of the sweet domestic virtues with the mighty faculties of a transcendent intellect. It gives honor to the claims of a homely life beside the demands of what are called the higher faculties, and goes far to break down the jealous partitions which less perfect natures have striven to put up between homeliness and intellect. Other lessons of his life are perhaps equally striking, each to the individual reader. With his scientific and philosophical discoveries the world is mainly familiar.

CHAPTER XXIII.

BACTERIOLOGY.

GERM THEORY ILLUSTRATED—KOCH—CONTAGIOUS DISEASES TRACED TO THEIR ORIGINS—MALARIA—HYDROPHOBIA—DIPHTHERIA—LOCKJAW—ANTITOXIN—ASEPSIS—NEW ERA IN TREATMENT OF WOUNDS—PASTEUR.

WO thousand years ago Varro, in Rome (B. C. 116-28), wrote: "It is also to be noticed, if be any marshy places, that in minute animals breed there h are invisible to the eye, and getting into the system through th or nostrils, cause diseases are difficult to treat." In 1675 ony von Leuwenhöck (1632-) greatly improved the com- d microscope. He discovered w world peopled by creatures of extreme minuteness and such dible numbers that putrescent ions literally teemed with them, drop of the liquid furnishing a uet for millions. Yet it was ill two hundred years later, in , that the scientific world, under eadership of Pasteur and Koch, n to give general recognition e germ theory of disease which w thoroughly established, and absolutely known that there ex- for most diseases of infectious n, specific germs. Hauptmann, e seventeenth century, sug- d that epidemic diseases might used by the presence in the air visible germs, and since then more or less plausible efforts been made to explain the phe- na of contagion. In 1863, Dr. Lionel Beale (1820) advanced the theory that the active properties of vaccine lymph were contained in certain minute particles $\frac{1}{20000}$ inch in diameter, a theory which has since been shown to be correct. Dr. Braidwood and Vacher describe the contagion of measles as "sparkling, colorless bodies in the breath of patients," and Dr. Klein, in typhoid fever, found minute organisms surrounding the affected intestinal glands. The blood of animals dead from splenic fever swarms with bacilli, which multiply and throw off spores that can be cultivated, and the crop continued from fluid to fluid. After seven or eight such crops, a rabbit or guinea pig inoculated with the artificially developed contagion dies from the same disease as the animal from which the contagion germ was taken. It has long been known that tuberculosis was hereditary, but it was supposed to be non-infectious. The tubercular bacillus has been discovered. Koch has cultivated it, and communicated it to animals, in whose bodies it has been found after death.

The tentative theories of Anton Leuwenhöck, L. Spallanzani (1729-1799), J. Muller (1801-1858), T. Schwann (1810-1882), C. G. Ehren-

berg (1795-1876), Herman K. F. W. Ludwig (1816—), Helmholtz (1821-1894), Bohn, F. G. J. Henle (1809-1885), and others, have been established. Louis Pasteur (1822—), in an investigation of fermentation by yeast, and putrefaction, demonstrated that both processes were due to the growth of organisms present in the air, and that putrefaction could be indefinitely postponed if these organisms could be kept out. Tyndall and Lister confirmed these positions, and gave the death blow to the doctrine of spontaneous generation, as well as pointed out the cause and cure of many diseases.

Says Professor John Tyndall (1820—), in allusion to the "germ theory," and the fact that millions of microscopic germs are rained upon human beings, multitudes of which may produce disease:

"The air of our London rooms is loaded with this organic dust, nor is the country free from its pollution. However ordinary daylight may permit it to disguise itself, a sufficiently powerful beam causes the air in which the dust is suspended to appear as a semi-solid rather than as a gas. Nobody could, in the first instance, without repugnance, place the mouth at the illuminated focus of the electric beam, and inhale the dust revealed there. Nor is this dust abolished by the reflection that, although we do not see the nastiness, we are drawing it into our lungs every hour and minute of our lives. There is no respite to this contact with dirt, and the wonder is, not that we should from time to time suffer from its presence, but that so small a portion of it would appear to be deadly to man." Rushing along continually in this pell-mell of microscopic myriads are the germs of most of the diseases that "flesh is heir to." Dr. S. E. Telliffe, of Columbia College, records thirty species of molds and yeasts derived from the air. An Englishman has calculated that there are 20,000 dust particles in the cubic centimeter in the open air, and 40,000 in a quiet room. This was in a suburban district. In London the figures were 300,000 in a court and 400,000 in a room.

The invisible plant-world seems as wonderful as that which we see. We are wading through the atmosphere in a sea of vegetation possibly as numerous as the fishes in the ocean. Mostly existing as spores, they are ever on hand to germinate and become living plants whenever the conditions are favorable. It is only when these spores germinate and become perfect plants that they are beneficial or harmful, as the case may be, to organic beings. Dr. Smith Ely Jelliffe took occasion to gather some of these and cultivate them during the three early months, and succeeded in raising no less than twenty-eight well-known species from these atmospheric spores. We have known for a long time past that these spores must be there, floating around in great abundance. No fruit rots on the trees or in our cupboards but the peculiar cryptogram that delights to feed on it starts into growth. No piece of bread can be placed anywhere but the spores that

grow on bread germinate in a forest of countless plants that we call mold. The microbe has the characteristics of the vegetable and the animal.

Says Dr. Lewis H. Watson: "In 1882 Koch exhibited samples of the stained bacillus tuberculosis discovered by him in 1881, before the Physiological Society of Berlin. His discovery has stood the test of time, and we know that every case of consumption must have this characteristic bacillus. Before 1882 it was a matter of opinion; physicians often differed. Now, if you find the bacillus, you have a case of phthisis. It is absolute. We not only learned that consumption was caused by a specific micro-organism, but we also learned that it was contagious, and although as yet we have not found the cure, we all look for it. Mortality has been lessened, cures have been and are being made when known in time. Hygiene here has taught us that we can limit its spread by destroying the sputum or matter expectorated, by burning. If it be true, as asserted lately, that a specific microbe has been found in the blood, even before the bacilli are found in the sputum, we may reasonably hope that the day of the cure is not far distant."

Robert Koch (1843—) also discovered the "comma," or cholera bacillus, in India, in 1883, for which he received a gift from the government of $25,000. His discoveries in bacteriology entitle him to rank among the great benefactors of humanity. The bacillus in lockjaw, erysipelas, typhoid fever, and influenza have been discovered and described; and serum therapy is a death-blow to the constant and excessive use of drugs.

One-half of all deaths have been caused by infectious diseases which result from the propagation of bacterial life, micro-organic creatures that propagate with infinite rapidity and numbers, and fifty per cent. has been added to life through bacteriological discoveries. And yet, the best results of these discoveries do not date back beyond twenty years. Already remedies have been found for diphtheria, lockjaw, septicemia, pyemia, puerperal fever, typhoid, scarlet fever; and to render surgical operations safe (by preventing blood-poisoning). A Japanese scientist has worked on a serum to destroy the bubonic plague, and a Hungarian medical man has undertaken to treat pneumonia in the same way.

The zymotic diseases are propagated by germs, or minute organisms, which rapidly increase in bodies where they obtain lodgment, and in which they find congenial conditions. These are smallpox, measles, whooping-cough, typhus, diphtheria, scarlet fever, cholera, etc. These germs are in drinking water, or in the dejecta of those diseased.

Perhaps the two most important discoveries of the Nineteenth Century relating to diseases of children are those of Klebs and Loeffler, who demonstrated the diphtheria bacillus as the cause of diphtheria, and the discovery of an antitoxin by Ronx

and Behring for its cure. This remedy is capable of saving twenty per cent. of the otherwise fatal cases. In the Charite hospital, Berlin, from 1886 to 1894, preceding the antitoxin treatment, the fatality rate was 53.6 per cent. From 1894 to 1898, only 15.9. In all the Berlin hospitals, from 1890 to 1893, inclusive, out of 8,080 cases there were 3,106 deaths, 38.4 per cent. From 1894 to 1897, inclusive, with 10,026 cases, 1,823 deaths, or 18.2 per cent. In London the decrease was from 22.5 per cent. to 4.7. If the process of the increase of a diphtheric germ has gone on unbroken for a single day, it is figured by eminent authorities that the total colony in twenty-four hours will number 16,500,000 active members. This population, provided nothing happens to hinder its growth the second day, would reach 281,500,000,000. This mass would then fill a pint cup. The product of the third day of uninterrupted reproduction is beyond comprehension when put into figures.

The use of antitoxin has greatly decreased mortality from diphtheria. In Berlin the death rate from 1889 to 1894 was 29.8 per cent. For the three following years, during which the antitoxin treatment was used, the mortality was only 14.7 per cent. In Paris, during 1886-1894, the number of deaths from the two diseases mentioned ranged from 1,106 to 1,788 per year. During the last three years the average number has fallen below 400. The rate of mortality in the London hospitals just prior to the use of antitoxin was 61.8 per cent. as compared with 17.2 per cent. for 1898. In 1894 there were nearly 2,900 deaths in New York City from diphtheria and croup. In 1898 there were but 900. In Boston the death rate for the two diseases for 1880-1894 was 30.75 per cent., while for 1895-1897 it was 12.61 per cent. In Chicago there has been a drop from a mortality of 30.36 per cent. to less than ten per cent. In 68,648 cases of diphtheria and croup in Europe and America during the last four years, which were treated with antitoxin, there was a death rate of 18.2 per cent. In 16,230 cases not thus treated the rate was 37.8 per cent. The antitoxin treatment is used also to secure immunity from diphtheria. Among 20,000 cases treated the disease was epidemic and all had been exposed to it. Only one fatal case was known to occur during the thirty days following the injection of the serum, while there were 109 mild cases during the entire month. The advancement made during the past fifty years may result in a largely reduced infant death rate.

The bacteriologists have discovered that typhoid fever is usually caused by swallowing within ten days prior to the attack, milk, water, or other fluid containing active typhoid bacilli. The latter can be destroyed completely by boiling, and thus absolute protection may be afforded against this dread disease by boiling all fluids. The organism is discovered with the microscope in the blood, in the excretions from the kidneys and bowels, and after death in the spleen, upon the lining mem-

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threw off germs. They were not bred in the air, he concluded, but were on the earth, and when dried, floated abroad. He employed carbolic spray to destroy them, and other measures to the same end followed, and surgery was revolutionized by the new science of antisepsis.

Says A. G. Gerster, M. D., in Dennis's "System of Surgery," pages 680-1: "We find that all microbes found suspended in the air are derived from the exposed surfaces of organic material. In examining the relative proportion of living germs contained in sputa, pus, street-dirt, slops, and the water of open sewers and canals, we encounter truly appalling quantities, and far outnumbering anything ever found in the foulest atmosphere. According to the researches made by the Berlin Hygienic institute, each cubic centimeter of the water of the river Spree contains from 3,200 to 154,000 germs, the average being 37,525. There are in each drop of pus millions of microbes, and these proportions prevail in every kind of decomposing material. Compared to this the 40,000 germs found in a cubic meter of the vitiated air of a lecture room are truly insignificant.

The "New England Medical Monthly" declares that "the new era of the surgical treatment of wounds, inaugurated by Sir Joseph Lister, of Edinburgh, in 1869 and 1870, became revolutionary, and is now accepted throughout the civilized world. In fact, the marvelous results in the speedy and safe repair processes, following antiseptic operations, were absolute demonstration,

and, after a time, the new teaching was almost universally accepted, until now, profiting by anæsthesia and antisepsis, the two greatest discoveries of the century, it is safe to assert that surgery has made greater advances in this generation than in the entire period since the Romans." Before antiseptic surgery the death rate from amputations was over sixty per cent., while now it is two per cent.; the mortality from ovariotomies was over seventy per cent., while now it is less than three per cent. Twenty years ago in hospitals there was one death from blood-poisoning (septic fever) in every thirty cases of childbirth, while now there is not one death out of five hundred childbirths. These figures will lead the reader to comprehend the great revolution in surgery that has taken place during the last quarter of a century.

LOUIS PASTEUR.

Lister's attention was attracted to the fact that in fracture of the thigh, when the skin was unbroken by the sharp point of the bone protruding, union was rapid and without what was called surgical fever. At first he supposed, as he had been taught, that laceration of the soft tissues was the cause of the great danger and delay in healing, which accompanied compound fracture (fracture where the bone protruded). But doubt arose in his mind, and he decided that the simple fact of the broken skin could not account for the increased mortality in such cases. About this time the scientific world was stirred by the experiments of Louis Pasteur upon fermentation and putrefaction, and by the controversy between Pasteur, F. A., Pouchet, F. A. (1800-1872), and Doctor H. C. Bastian (1837), upon spontaneous generation; the former asserting that all life must proceed from life, whereas Pouchet and Bastian declared that life was constantly originating "*de novo*" from the juxtaposition of certain organic elements favoring its development.

Doctor Van Helmont's humorous receipt for producing a pot of mice, well satirized the scientific theories of less than fifty years ago: "It suffices to press a soiled shirt into the orifice of a vessel containing a little corn. After about twenty-one days the ferment from the soiled shirt, modified by the odor of the corn, effected the transmutation of the mice. It is only necessary to pair them to prolong the species."

Says the "New England Medical Monthly": "The Italian Redi was the first to subject this question of spontaneous generation to a more attentive examination. He showed that maggots in meat are not spon-

THE LOGAN STATUE.

"General Logan *represents the Ideal* American soldier, magnetic, fearless and dashing."

1. Gen. Charles G. Gordon. 2. Louis Kossuth. 3. William McKinley.
4. Marie F. S. Carnot. 5. William E. Gladstone.
6. Emperor William I. 7. Joseph Chamberlain. 8. Sir Garnet J. Wolseley.

taneously generated, but that they are the larvæ of flies' eggs. It is only necessary to surround the meat with gauze before exposing it to the air. As no flies can come in contact with it, there are no maggots. It remained for Pasteur to demonstrate to the scientific world that spontaneous generation was a chimera. He heated flasks containing putrescible fluids to the boiling point, and then drew out the neck under the heat of a blow-pipe, and sealed the flasks. While thus sealed, every germ having been killed by the boiling, and a vacuum existing between the mouth of the flask and the liquid within, no life became visible. It was only necessary to break the neck of part of the flasks and admit the air, to have the fluid swarming in a short time with germs.

"Lister, having learned from Pasteur that the putrefaction of animal tissues, and the fermentation in the must of wine, and the wort of beer, were caused by the action of certain micro-organisms, called ferments, he reasoned that if it were possible to keep these germs from coming in contact with open wounds, pus formation would be avoided. It had been noticed that if the edges of wounds produced by a sharp cutting instrument were brought in close adaptation, and maintained in this position the wound healed without the formation of pus, or the supervention of fever. This action was at the time called 'healing by first intention.' When a wound was ragged or torn, the edges became everted, and after a few days a thick, creamy fluid covered its surface. This was called 'laudable pus,' and was supposed to be necessary to the healing process. Lister conceived the idea that if he could find some substance strong enough to kill the micro-organisms without injuring the tissues, there would be no pus formation, which only caused sloughing, and retarded the return to a natural condition. By the advice of Dr. Anderson, professor of chemistry at Glasgow University, Lister tried carbolic acid, which was then nothing more than a mere chemical curiosity. He saturated gauze with a solution of the acid, and applied it to open wounds, covering the gauze with gold beater's skin. He was delighted to find that his reasoning was correct, for the wounds healed without fever or the formation of pus. Here began antiseptic surgery. It was supposed that the germs floating in the air were the cause of all this trouble, as they necessarily constantly fell upon the wounds. To avert this, and kill the germs, the air was sprayed with carbolic acid, and later with corrosive sublimate; the wound and the operator were also sprayed during an operation. It was some time after this that it was learned that the germs of atmospheric air were not the fermented germs which caused putrefactions."

Hydrophobia, or rabies, is now treated by inoculation. The method was first propounded by Pasteur, the principle of which consists in injecting into the circulation of the patient a fluid impregnated with the virus of rabies, that virus having been attenuated and weakened by a successive passage through the sys-

tems of animals in whom the poison has a tendency to diminish in potency. The logic of events renders it certain that the treatment, if applied early enough after infection, will avert an attack of rabies. When Pasteur discovered the germs of disease in the microscopic microbes and said: "Behold the enemy," and Sir Joseph Lister, in the antiseptic treatment of wounds discovered the agencies that destroy them, the greatest achievements ever made in medical science were accomplished. Since Lister's aseptic treatment of wounds, pus does not form and wounds heal by the first intention. Pasteur was a chemist, to which fact his remarkable discoveries are due. His discoveries relative to the polarization of light (1856) and others rank him among the great scientists of the world.

In 1865, Davaine found bacillus anthracis in the blood of those having splenic fever.

Eberth discovered the typhoid bacillus. Yersin that of the plague.

The curious discovery by modern science of the remedy for diphtheria is thus described by James E. Newcomb, M. D. ("New York Independent," October 7, 1897.) "It is obtained from the blood of the horse. The animal is injected with a dose of the diphtheria poison, renewed in increasing strengths until he ceases to react—that is, until he ceases to manifest any disturbances from the process. A certain amount of blood is then withdrawn from one of the veins and allowed to form the usual clot, which, after awhile, separates into two parts, one hard, called the clot proper, and the other fluid, called serum. It is found that this serum has the power of counteracting the effects of the diphtheria poison. The serum which contains the antidotal principle can be injected into the body of a person suffering with diphtheria, and will, with tolerable certainty, neutralize the effects of the disease poison which the system may have already absorbed. To obtain satisfactory results the injections should be made as early in the disease as possible. The happy result is not probably a simple process of chemical neutralization, as where we may use an acid and an alkali to neutralize each other, but the antitoxin doubtless acts by increasing the resisting power of the normal cell elements and so enabling them to withstand the effects of the poison. Normal body cells have this inherent power, and this is the reason why we are not sick much oftener than we are; for we are constantly surrounded by deleterious bacterial influences. The process, therefore, is really one akin to vaccination, and there is little reason to doubt but that, in time, we shall possess antitoxins against other of the contagious diseases."

It is now believed that most diseases result from germs, taken with the breath or the food, and one by one antiseptics are being discovered that will destroy the noxious germs, while not injuring the human tissues.

Surgical cleanliness is a triumph of this century. Until less than fifteen years ago its importance was not known. Surgical practice was attended by suppuration, erysipelas,

lockjaw, gangrene, now practically unknown in well-conducted hospitals, and with qualified surgeons, and other serious and often fatal sequels. Now the hands, person and clothing of surgeons and nurses, and the instruments and all the vessels and articles surrounding the patient are entirely cleansed, in order that almost no bacteria can infect the patient. So that, whereas, twenty years ago surgical operations were always attended with danger and liable to fatal results, now they are almost unknown. The bacteria that are on the human skin, clothing, and in the atmosphere of all rooms not rendered aseptic, do not assail the exposed tissues. Seventy-eight species of bacteria have been detected on the human skin. Formerly "eighty per cent. of all wounds were attacked by gangrene—erysipelas was the order of the day,—healing by primary union did not exist,"—but now all is different. Asepsis prevents, and antisepsis cures where once great dangers attended surgical operations.

The surface of the body, even of the most cleanly, swarms with fungi, bacilli, and cocci.

Dr. Lewis H. Watson explains what is meant by surgical cleanliness. The hands of the operating surgeon, assistants, and nurses, are thoroughly scrubbed with soap and water, using a nail brush, the surgeon even removing a ring if he wears one. The finger-nails are also very carefully cleaned. After thorough cleansing the hands are dipped into alcohol, or have ether poured over them to remove all oily matter, which might harbor bacteria. The hands of the operator and assistants are now immersed in a solution of corrosive sublimate, or carbolic acid. The surgeon and his assistants wear long aprons, which have been boiled and freshly laundried. The person of the patient has already been just as carefully prepared, and is as surgically clean as that of the surgeon and assistants. Every instrument has been placed in boiling water, or subjected to the action of superheated steam, and is now on a tray in an antiseptic bath. Every ligature has been boiled and preserved in glass-stoppered bottles, in an antiseptic. Every dressing and bit of gauze, and all the sponges are equally as carefully prepared. Nothing can be more exquisitely clean than patient, surgeon, assistants and instruments. This is asepsis. This is the triumph of modern surgery, and to such a point of absolute perfection is the art brought at the present day, that except in a case of malignant disease, or gun-shot wounds, and injuries of a necessarily fatal character, death is the exception and recovery the rule. Sepsis means putrefaction, or germ poisoning. Antisepsis, in a surgical sense means the destruction of the putrefactive (pus-forming) germs. Asepsis means the absence of putrefactive germs. To Lister belongs the credit of antisepsis, and to Keith of asepsis.

G. F. H. Kuchenmeister (1821), of Dresden, reported good results from carbolic acid in 1860; Lemaires' work appeared in 1863; Campbell de Morgan used chloride of zinc in 1866, but Lister establishes antiseptia on the basis of Pasteur's experiments

in 1867-8, by showing that putrefaction is due to micro-organisms, and who found means to prevent their entrance into wounds, or to destroy them after they had entered.

The most important bactericidal agent is heat, in the form of the cautery, boiling water, steam, or hot air. After heat, come, in the following order, bichloride of mercury, iodine, chlorine, bromine, bichloride of iodine, cresol with sulphuric acid, carbolic acid, creoline, ligneous vinegar, chlorate of lime, turpentine, formic acid, etc.

The discovery by Dr. T. E. Klebs (1834) and Dr. Sanarelli, in 1883, of the bacillus diphtheriæ, and by Loffler, in 1884, show the cause of diphtheria; and the discovery by Klebs, in 1898, of the yellow fever germ are of great value. The origin of the latter is amœba and not bacillus. The disease is not infectious, and the quarantine will not be necessary, as it has been thought to be in the past; to avoid the disease it will be needful to thoroughly disinfect the foods and drink that enter the stomach.

Tetanus (lock-jaw) had always been supposed to be caused by a punctured nerve, but in 1884 Carle Aosdrattone showed that it can be produced by the inoculation and injection into a rabbit of the contents of a pustule which has been the starting point of the disease in man. At the same time Nicolaiert in 1884-5, showed that inoculation produced tetanus in animals, and that in the center of the inoculation the special form of the bacillus, swelled at one of its extremities, was always to be met with.

The Japanese, Kitasito, in 1889, confirmed by his researches the microbic character of the disease and the identity of the human tetanus with the experimental tetanus.

The tetanic bacillus secretes a very active poison. It was discovered by Kund Faber, in 1890. This poison, when used to inoculate animals, causes the same tetanus found in men, injected by the disease. The tetanus bacillus is shaped like a drumstick.

Koch, in 1882, discovered and cultivated the consumption germ (bacillus tuberculosis), and at about the same time Baumgarten microsopically demonstrated it. So of erysipelas, Fehleisen (1883); leprosy, Hansen (1879); glanders, Loffler and Shutz (1882). The doctrine of Phagocytosis is one of the greatest of modern discoveries. It was first suggested by Sternberg, and developed by Metschnikoff, of the Pasteur institute. It is known that the human body, and the bodies of animals, are beset constantly by myriads of bacteria. They wage a constant warfare to obtain a foothold, and destroy organized matter, but within all living bodies there is also a defensive host, an army of cells called phagocytes. In the blood secretions and tissues, these "infinitely little" cells keep up a constant, watchful promenade. Let but the skin be broken, or, through disease or some breach in the integrity of our defenses, an opportunity be offered for the besieging army of bacteria to affect an entrance, and

this defensive garrison, ever on the alert, rush through the blood-vessels, tissues, and all obstructions, toward the part attacked. Each phagocyte seizes not one, but many of the invading bacteria, and swallows them, renders them inert, and then, crammed with the dangerous army, it makes its way outside the body and dies. Nothing could more fully illustrate the action of these phagocytes than what occurs when, during a walk, you jab your stick into an ant-hill. Then you see the scurrying horde fly to the point attacked, and try to repair the damage. So, in their unconscious, blind way, carrying out the theory of their organism, do the phagocytes, obedient to the instinct which governs their acts, unwittingly serve the host which entertains them, and thus is the integrity of our organism maintained. These white corpuscles, or leucocytes, are produced by the spleen, an organ whose office was until recently unknown. They inhabit the blood, and destroy and consume the bacteria or disease-germs that get into the circulation.

Metchnikoff points out that antitoxins (or the antidotal principles formed in the blood after inoculation with disease germs) appear in the animal kingdom much later, as we progress from low to high life, than does the beneficent work of the blood corpuscles. The resistance of an animal to any disease, he concludes, is really the result of the work of white blood corpuscles, and not of antitoxins; while he points out also that even the antitoxins are prepared by the blood. The suggestion here is that, when all is said and done, it is the white blood-cells which are the chief agents in securing immunity from disease-attack.

The discovery of the origin of many diseases in vegetable or animal germs, has dispelled the mysteries of disease, and the discovery of asepsis and antisepsis destroys the power of an army of the enemies of human health and life. The entire science of cause and cure are the work of the century. It is probable that the spores of those minute plants which produce our epidemic diseases, are always with us, and extending wherever the atmospheric current may go in which they were originally produced. The germs of yellow fever, even, may be taken into our lungs with every breath, in localities where yellow fever has never been known, but do not find the necessary conditions to germinate into full grown plants and then become virulent. We may never stamp out the spores by quarantining. The atmosphere cannot be quarantined.

James Paget, in London, in 1833, found the cocoons of trichina spiralis, in disecting a human body, in 1847. Joseph Leidy, of this country, found the same parasites encysted in pork; and Virchow announced that the parasite was introduced into the human body by pork eating. Thus was trichinosis discovered.

The discovery of the trichina and the cause of itch (1834) (a microscopic insect burrowing under the skin), gained with the great improvement of the miscroscope, seem to

have been the signal for the wonderful discoveries of microscopic germs that have since followed. Louis Pasteur began his great career by studying alcoholic fermentation, in 1854. It was soon discovered that yeast, and all putrefying substances were innumerably populated by animal or vegetable germs. Pasteur, in 1857, published the results of his researches, showing that all putrefaction, fermentation and decay resulted from the activity of microscopic life.

These discoveries suggested the possibility that diseases might be caused by these minute forms of life. Davaine, Koch, Ronx and Pasteur soon demonstrated, by experiments with diseased silkworms, and sheep affected with splenetic fever, that bacteria caused the malady. From this time on discoveries rapidly followed one another. Villenion showed, in 1866, the infectious character of tuberculosis, and Koch discovered the bacillus that caused the disease. In 1880 the cause of malaria was found by J. K. Mitchel, and (see elsewhere) methods of culture, attenuation and inoculation soon followed, and antitoxins have been found to arrest these diseases, also diphtheria, tetanus, cholera, hydrophobia, snake-bite, typhoid, septicemia influenza, etc.

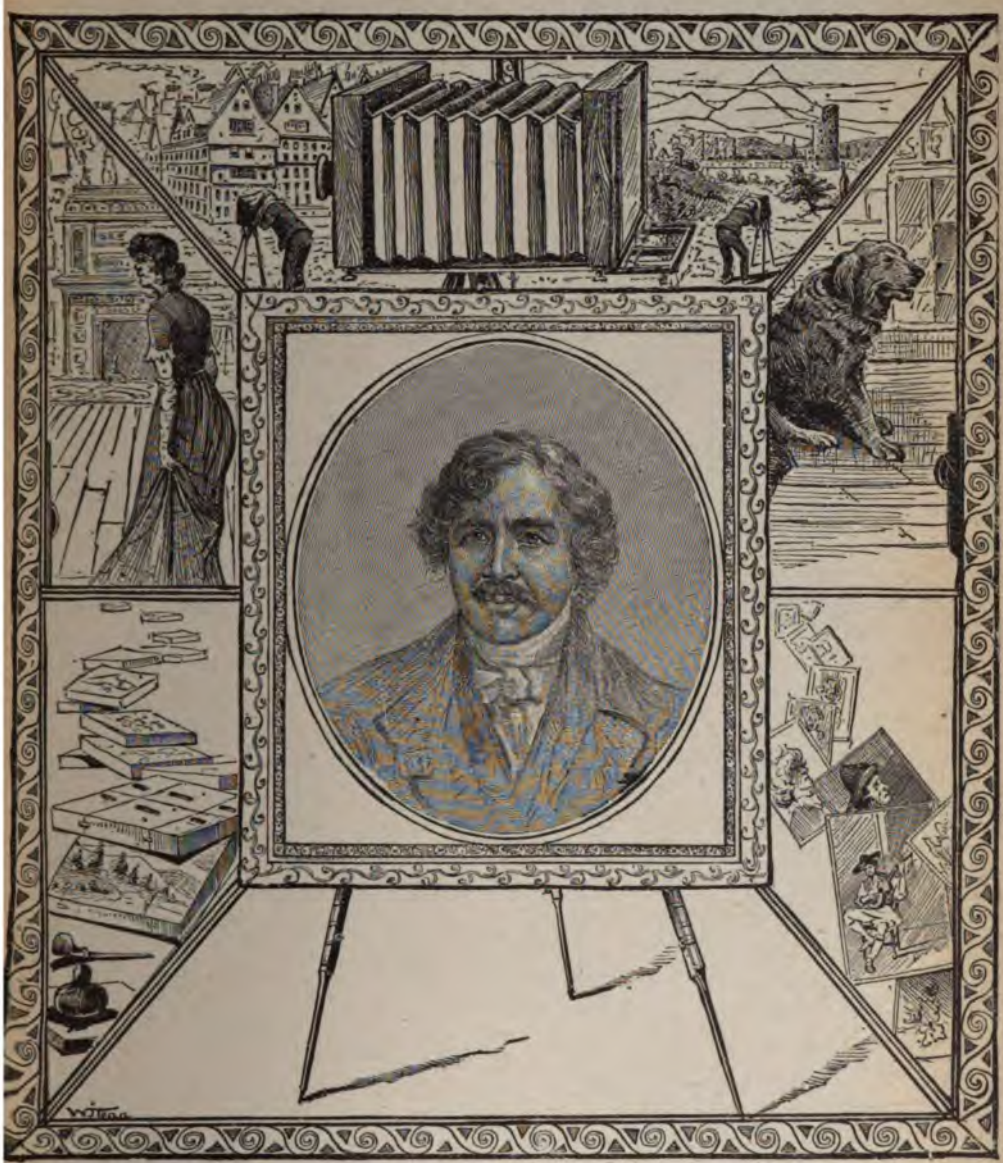
Professor Virchow, in his Huxley lecture in London, October 23, 1898, forty years after his great work on "Cellular Pathology," said, "The basis of our comprehension of the theory of medicine actually rests nowadays on minute microscopic investigation, for the elaboration of which the animal tissues form the indispensable control object. . . . For the life of an organ is naught else than the sum of the lives of the single cells which are gathered together into it; and the life of the whole organism is not an individual, but a collective function."

Liquid air is already astonishing the world with its antiseptic disease destroying properties. Hospital rooms in the tropics or elsewhere, from New York to Calcutta, may be kept at any degree of frigidity, destroying all germs of disease, and not only making yellow fever impossible but instantly stopping the ravages of that dread scourge. A bit of the liquid sprayed on dangerous wounds will arrest blood poisoning. It is said that the cauterizing effect of a spray of this liquid frost, 312 degrees below zero, is a thousand times more effective than nitrate of silver, which destroys the flesh, or lunar caustic, which cannot always be controlled. With liquid air cauterization can be stopped instantly. Cases of hay fever, asthma, diphtheria, the grippe, and those terrible throat and pulmonary diseases that are carrying off sixty per cent. of all who die, can be cured by the spray of liquid air. The marvels that it is said liquid air will accomplish are beyond belief, but they have not yet sufficiently materialized to be stated here. They promise to revolutionize medicine, machinery, and to stand as the great achievement of the twentieth century.

Bacteriology is one of the most remarkable of the achievements of the "Century of Centuries."

L. J. M. DAGUERRE

[Born 1789. Died 1851.]



From every point of view, the grand discovery of Daguerre is one of the most useful that has signalized the century we live in; and its possibilities seem all the greater when we consider its earlier achievements in the light of present adaptability to the multitude of purposes for which it may be employed. If printing is the art preservative of all arts, photography merits a still higher place, since it preserves for us an exact counterpart of the object itself.

CHAPTER XXIV.

DENTISTRY.

BARBAROUS METHODS OF TEETH-PULLING IN 1800—NO ARTIFICIAL TEETH—NO TEETH FILLING—GEORGE WASHINGTON'S HIPPOPOTAMUS TEETH.

THE portraits of the men and women of the last century, when not flattered by the brush of the artist, show us how much they needed the coming benefactor, who had not then arrived, the skillful dentist. Their mouths recede as nose and chin approach each other. False teeth were rarely known, and then rude and temporary expedients were resorted to. Artificial teeth were made of ivory, or were the teeth of others who had done with them. Volney, Chateaubriand, the elder Pitt, and the great Washington wore teeth carved from ivory. Porcelain teeth made of felspar, silica, and kaolin were first made in 1830. A cruel, torturing turnkey dragged out an offending tooth, and sometimes in the process dragged the agonized owner all over the doctor's office before the conflict ended. No anæsthetic soothed the pangs of one who must part with his decaying ivory, for "the tooth-carpenter" had not yet learned the trade that repairs the ravages of time, and makes the middle-aged and even the aged presentable, besides bestowing pleasure in eating, and prolonging life by rendering mastication of food possible. The barber and the doctor extracted teeth. Improved appearance, comfort in eating and speaking, health and length of days are among the benefactions bestowed by the art of Dentistry.

The most that our ancestors in the last century could do with their aching teeth was to extract with torment excruciating an offending member. Now it is known that all teeth, with rare exceptions, may be preserved; that decay may be arrested after it has begun; that the pain of dental operations may be entirely avoided; that artificial teeth may be inserted that defy detection from the original by the most critical eye, and that are far more convenient to the wearer and attractive to others than the average teeth that nature bestowed. Health, comfort, and appearance are all promoted by the dentist's art.

During the last century several English and French practitioners followed the profession in this country—John Woolfendale (1741-1828), James Gardette (1831), etc. Dr. John Greenwood (1816) was dentist to George Washington. He carved a full set of artificial teeth from a hippopotamus's tusk. In 1798 he wrote to the Father of his country a letter from which we extract: "I send you two sets of teeth, one fixed on the old bases in part, and the set you sent me from

Philadelphia, which, when I received it, was very black, occasioned either by your soaking them in port wine or by your drinking it. Port wine, being sour, takes off all polish, and all acid has a tendency to soften every kind of teeth and bone. I advise you to either take them off after dinner and put them in clean water, and put in another set, or clean them with a brush and some chalk scraped fine. If your teeth grow black, take some chalk and a pine or cedar stick; it will rub off. If you want your teeth more yellow, soak them in broth or pot liquor, but not in tea or acids," etc.

In 1754 Washington lost the first tooth, and from that time to 1795 he lost one or more each year. The last one was extracted in the last named year. Doctor Greenwood, his dentist, wore Washington's last tooth as a watch charm. Meanwhile he had clumsy substitutes manufactured to fill their places, but they wretchedly answered the purpose. In 1783 he wrote to Andrew Billings, in "Poughkeepsy," from Newburg, for a small file, so that he could separate his teeth. Billings was an ingenious watchmaker. Washington was wearing a set in 1789, when his carriage broke down, and the upper portion was cracked. This he sent to Doctor Greenwood, in 1791, to repair, with orders for another double set. The last were made to accommodate his last tooth, which passed through the foundation of the set, but it pained the great man so, that in 1795 it was extracted. The two sets were carved solid—plate and teeth—from the tusk of the river-horse. They were joined at the back ends by gold wire spirals. The different appearances of Washington's mouth, in his portraits, are due to his defective natural, and more symmetrical artificial, teeth.

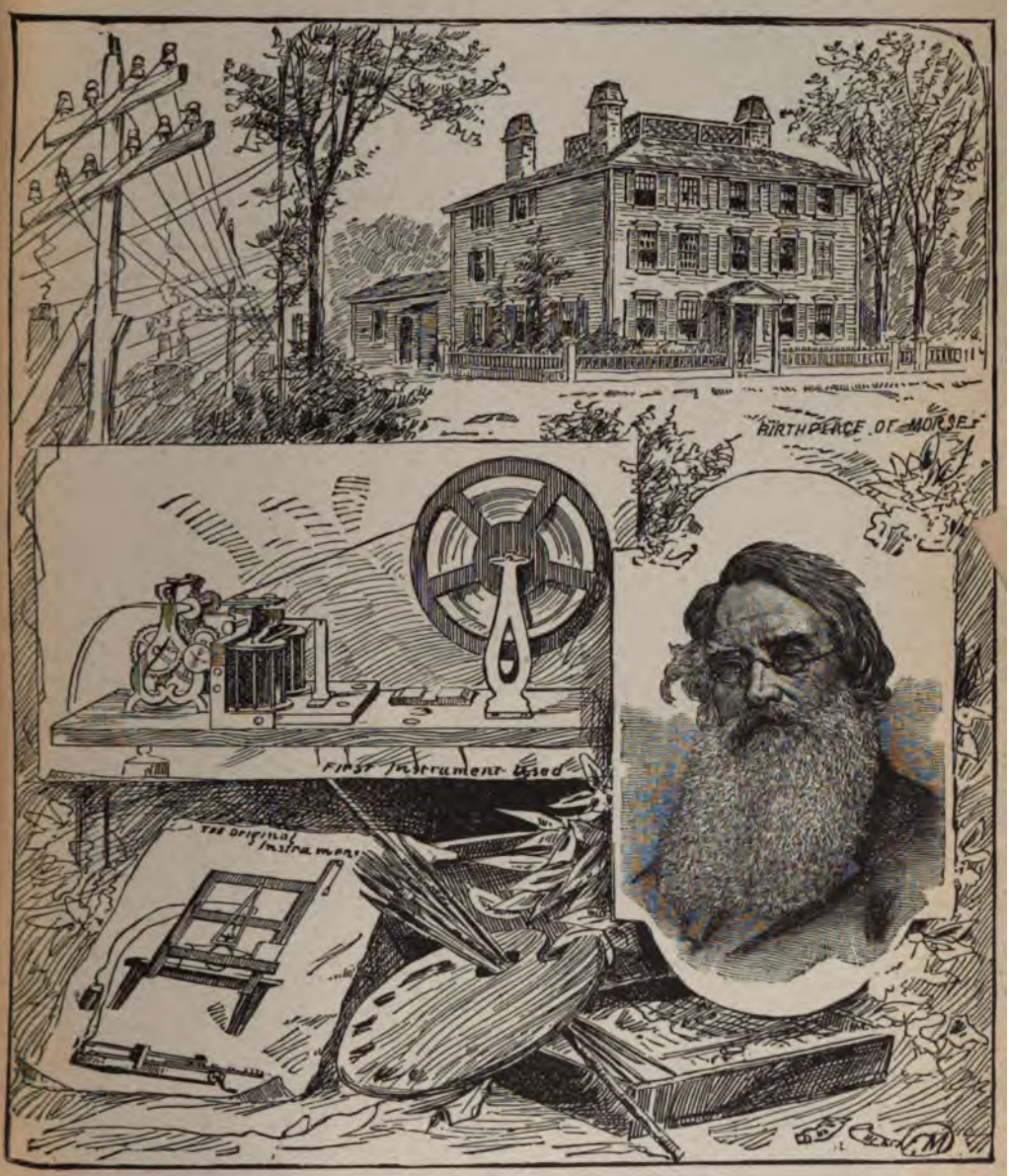
It was not until 1820 that the profession was much followed, and even then the art was in a very crude condition. In 1800 there were one hundred dentists in the United States. The only prominently known dentist in the United States in 1822 was J. Brockway. In 1894 there were 25,000.

The first enameled teeth of clay were made in 1808. They were very coarse, and were fastened by platinum clasps, baked in. They were not introduced into this country until 1829. Before this, dead men's teeth were transplanted in place of those extracted. The modern forceps was introduced by John Tomes, in 1841. Before that the hawkbill and turnkey wrenched out the aching offender. Horace Wells (See "Anæsthesia") introduced nitro-oxide. This discovery was not well received, but he continued its use. In 1845 gutta-percha came into use. Morton used ether in 1846, and in 1848 Doctor Evans, an American dentist in Paris, began the use of the rubber plate. The first swaged gold plate was employed in 1830. Teeth were at first inserted on pivots, and were held in place by silk, and then by gold wire ligatures.

No art has added more to human comfort and to the appearance of the human face divine, than has dentistry, one of the century's triumphs.

SAMUEL F. B. MORSE.

[Born 1791. Died 1872.]



It is unnecessary here to record the progress of telegraphic communication throughout the globe. Most truly has it annihilated space, and thus joined the hands of all peoples on the face of the globe in one grand, magnetic impulse toward a higher civilization, which through instant interchange of deeds or ideas is silently working out its promised fulfilment. Before this discovery Archimedes' boast fades into insignificance. With a spark Professor Morse has not only moved the world, he has illuminated it without other fulcrum than his own superior intelligence.

CHAPTER XXV.

MISCELLANEOUS INVENTIONS.

INNUMERABLE INVENTIONS NAMED—THE BAND SAW—CIRCULAR SAW—GIMLET—POINTED SCREW—PINS—SHOE-MAKING—SHOE PEGS—TUBULAR LANTERN—CELLULOID—REFRIGERATION—STEEL—DIAMOND DRILL—WATERWORKS.

THERE are many factors to be considered in the growth of the world, but the chief of them is Invention. It has made the waters a highway which men traverse as they do solid land, and, with Discovery, has lifted the nations from skins and caves to royal purple and palaces. The air of this planet, echoing the hum of spindles, the soughing of locomotives, the roar of the speeding trains, the clang of hammers, the murmurs of the telegraph wires, and all the innumerable clamors of machinery, chants to all its remotest limits a hymn of praise over the results of invention. "The beginning of civilization," says Sir Humphrey Davy, "is the discovery of some useful arts by which men acquire property, comfort, and luxuries."

THE WATER SYSTEM OF OUR GRANDFATHERS.

Among the greatest of the promoters of invention are the liberal patent laws of this century. They have so encouraged and stimulated invention that more has been accomplished by human ingenuity during a hundred years than would have been done in a thousand without them. Another is the Royal Institution, founded in London by Count

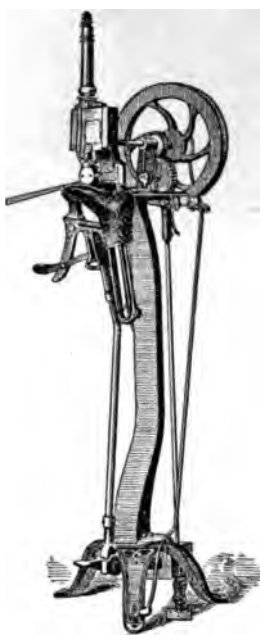
Benjamin Thompson Rumford (1752-1814), Sir Joseph Banks (1743-1820), and others, and incorporated January 13, 1800. It is designed to

THE OLD WAY.

diffuse knowledge, to facilitate the general introduction of mechanical inventions, and teach by lectures and experiments the application of science to the common purposes of life. It has, as a rule, had for its lecturers some of the first scientific men of the age. It has been one of the chief promoters of scientific progress in Great Britain during the Nineteenth Century, and, reinforced by American patent laws, has had great influence on the English-speaking race.

It seems incredible, as we look back to the year 1800, that nearly all the great inventions and discoveries, as well as thousands of those less prominent, and yet that seem absolutely necessary to comfort, had not arrived, excepting the screw, the lever, the wheel, the windlass, the mariner's compass, gunpowder, movable types, and poor microscopes and telescopes. Most of the great inventions, discoveries, and improvements, and the greater number of common conveniences among men, originated during the Nineteenth Century, and most of the ancient discoveries have been so reinforced by subsequent appliances that their originators would scarcely recognize them.

It would seem that the more inventions there are, the more additional patents are suggested. In England, for one hundred and fifty years prior to the middle of the eighteenth century, the patents granted for mechanical inventions were at the average rate of eight per annum. From 1763 to 1852 the annual rate was two hundred and fifty. During the next eighteen years it was over two thousand. In 1877 it was three thousand two hun-



A MACHINE PEGGER.

dred. France averages nine thousand, and this country twelve thousand, patents annually. The more the mind of man invents, the more it can invent.

Besides the inventions herein chronicled under special heads, are innumerable others, a few of which may be referred to.

Aerial navigation is an acquisition of the century. Elongated gas-bags are propelled through the air and steered by rudders. Gifford, in 1852; Dupuy de Lome, in 1872; Tissandier, in 1883, and in 1884-5, Renard made a speed of fourteen miles an hour. The French war-balloon in 1884, in charge of Messrs. Renard and Krebs, with a nine horse power motor, accomplished successful journeys in the air. The French and other European nations are pushing experiments in the direction of aerial navigation, and the outlook promises success in the twentieth century. Flying machines and machines for mechanical light are in embryo yet, but the advocates of this method of transportation are sanguine of success in the near future.

Does it seem credible that before the year 1800 there was not a planing mill in the world; that all lumber was planed by hand labor? Malcolm Muir, of Edinburgh, patented the first one ever seen, in 1827, and the next year, 1828, William Woodworth, of New York, produced what is now regarded as the best in use.

The band saw is another product of the century. A Frenchman, Touroude, in 1815 invented, and improved in 1845, this useful tool. In 1855 Perin produced an improved band saw at the International Exposition. But it was not until 1878, at the Paris International Exposition, that Fay, of Cincinnati, and Rogers, of Norwich, Conn., presented band saws pronounced to be perfect. The "Mechanical Dictionary" describes 160 different saws with differently formed teeth.

The scroll saw is in the same category. It is in several shapes, as it has been invented or improved by Wells, of Pennsylvania, Tapley, of New York, Beach, Fay, Rogers, and others. As a toy for the amateur, and moved by the foot, or attached to steam or water power or electricity, it can produce almost any form of use or beauty.

The circular saw was invented only as recently as 1805, by Brunel, of England, but it did not come into use to any extent until about the middle of the century. Benjamin Cummings, a blacksmith of Bentonville, N. Y., has the credit in the books of having made the first circular saw ever constructed in America, in the year 1814, in a common blacksmith shop. Would it not be a curiosity to look at now, by the side of a regular Disston seven-foot circular, such as are made for sawing eight or ten foot California redwood logs? But the difference would not be much, if any, greater between that blacksmith-made saw and the modern circular than exists between the modes of lumber-making then and now. But circular-saw mills, after having quite a run, are not now much used except in small establishments. The great pine mills work mainly with gang of up-and-down saws that split an entire log at once, and a first-class pine mill of the present is capable of cutting

more and much better lumber in a day than their best predecessors of a century ago could cut in a year. Such is the difference between then and now in this great line of industry; great mills upon the big rivers and railways are supplying all the world of prairies and cities and towns with unlimited quantities of lumber of every description; and what is still better, many of the best arranged mills are adapted with drying appliances, capable of drying all of the better grades of lumber they make as fast as it is cut, the surplus sawdust furnishing ample fuel for the purpose.

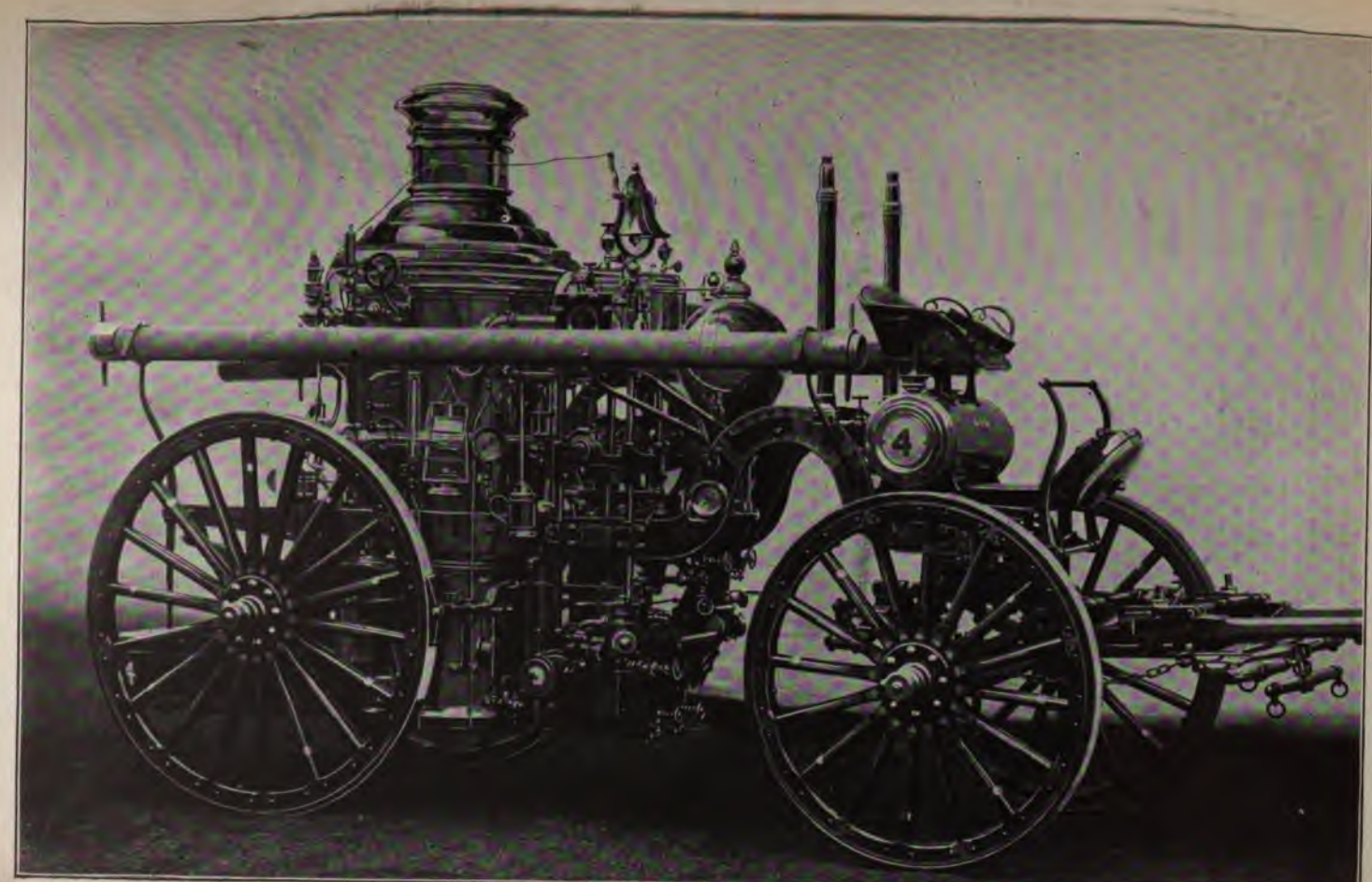
The mortising machine, in rude form, was made first by Brunel in 1807, and was improved by Branch, of New York, in 1826. Subsequent improvements have brought it to its present state of usefulness.

A machine for manufacturing veneering was first used, in an imperfect form, in 1793, but later a circular-saw process was introduced.

Thomas Blanchard (1788-1864) patented, in 1815, a remarkable machine for turning irregular forms, such as hat blocks, lasts, gun stocks, wheel spokes, gun-barrels, etc. He was a remarkable inventor, having, during his lifetime, invented twenty-five different machines. When but thirteen he invented an apple-paring machine that accomplished more than a dozen girls could do in the same time. His inventions have been equally useful and ingenious. He began his active life by making tacks by hand. He conceived the idea of making them by machinery. At the age of twenty-four he completed a machine that by placing the iron in the hopper, it would turn out five hundred finished tacks a minute, and a better article than by hand. His next invention was the lathe that would turn a gun barrel; then one for the turning of gun stocks, which holds its place to the present day. The machine on which his fame rests is the machine for turning gun stocks and other irregular forms. There have been some improvements on his invention, but it is substantially the same as his at first. It is used for turning ax handles, the spokes of carriage wheels, etc.

There are machines, nearly all of American origin, for turning broom handles, pulling stumps, making matches, barrels, carving, sand-papering wood surfaces, making boxes, etc., all the product of this ingenious age.

David M. Smyth was born in the north of Ireland in 1833, and came to this country when an infant. He is author of more than two hundred patents, among them the gimlet-pointed screw, which he invented in 1847, and sold to the reputed author, T. Sloan, for $1,000. James W. Harvey invented machinery for manufacturing it, and he and his associates, Angell, Sloan, and Whipple, realized large fortunes from its sales. A platform scale for which he received a gold medal and $2,500 for a one-half interest; a machine for placing the spangles on hoop-skirts, for which he received $3,000 and the purchasers realized $300,000 a year; a machine for making paper collars; another for fancy stitching



A MODERN FIRE-ENGINE.

"Previous to 1830 a square tub equipped with a hand-pump was used to fight fires."

UNION STOCK YARDS.

on shoes; another for sewing soles on shoes; the rotary looper of the Wilcox and Gibbs sewing machine; a famous bookbinder, which is now in use in all countries and on which he has forty patents; a bookbinder's gathering machine; a machine to cut envelopes, which reduces the waste from 30 per cent. to almost nothing—are among his inventions. He employed Edison to make the first dynamo ever made, which was his own invention, and is now in his possession in Pasadena, Cal. The first sole ever sewed on a shoe was by a machine invented by Mr. Smyth in 1861, but it was found that the stitches soon wore off. Donald McKay suggested the channel in which the stitches run, and he realized millions from the simple expedient. It revolutionized the boot and shoe manufacture.

The Goodyear method of sewing shoes, the McKay lasting machine, the electrical sole-sorter, the Brennahan sole-shaper and other machines, have reduced the shoe manufacture almost to an automatic process.

Once pins were made by cutting brass wire into the proper lengths; then the point of each was made on a grindstone; then a slender piece of wire was bent into a circle for a head, and was fastened on the body of the pin. It must have taken an expert workman not less than a minute to construct one of these useful articles.

In 1824 Lemuel W. Wright, of Massachusetts, patented machinery in England for making solid-headed pins; in 1840 Samuel Slocum originated a machine for inserting them in the paper. Thaddeus Fowler, of Connecticut, made an improvement on this invention. In 1844 Dr. John T. Howe imported one of Wright's machines, which was improved until it produced 8,000 pins an hour. "Many packages of pins may be bought for the amount asked for a single pin in those days; yet each one of these little articles—so cheap that the least coin in any civilized country is large enough to buy many of them—requires very expensive machinery and the attention of several men and women to make it. The process of making the wire from which the pins are manufactured is of itself slow and complex, but it is not considered in pin making, because the wire is made by one manufacturer and sold by him to another, who makes the pins. This wire comes in coils of great length, and is just the size of the body of the pin. It is first drawn between six or eight little rollers, to press all the bends and kinks out of it. The machine which does this also winds the wire carefully on a large reel; and this reel is placed on a spindle attached to the machine which makes the pins. When a reel is put on the spindle a workman inserts the free end of the wire between two steel rollers, which draw it in and feed it properly to the cutters. After this it continues to feed itself. As the wire leaves the rollers it passes between two matched dies until it touches a gauge. Just as it does this the dies come together and clamp it firmly in a groove in their face. At the same time the ma-

chine cuts it off the proper length. The gauge then moves away, and a little punch forms the head by striking the end which rested against the gauge. When this is finished the dies separate and deliver the pin into one of a great many grooves in the face of a wheel about a foot in diameter, and just as wide across its face as the pin is long.

"As soon as the first pin leaves the dies, the feed rollers send the wire between them again, and the whole operation is repeated. When the pin is taken by the wheel it has no point; but as the wheel turns it rubs the pins against an outside band, which causes each one to roll in its groove, and at the same time carries them past a set of rapidly moving files, which rub against the blunt ends and sharpen them roughly. They next pass against the faces of two grinding wheels, which smooth the points, and then to a rapidly moving leather band having fine emery glued on its face. This gives them the final polish; and as they leave the band they are dropped into a box underneath the machine. This machine works so rapidly that it makes 7,500 pins an hour. After this the pins are plated with tin to give them a bright, silvery appearance. They are prepared for plating by being first immersed in weak sulphuric acid, to remove all grease, and then dried by being placed—a bushel or so at a time, with about the same quantity of sawdust—in a machine called a tumbling barrel. This is simply a cask suspended on a shaft, which passes through it lengthwise. The shaft is made to turn by means of a belt, and in doing this it revolves the barrel. Two or three hours rolling in this sawdust cleans the pins and wears away any little roughness which the machine may have caused. Pins and sawdust are taken together from the barrel and allowed to fall in a steady stream through the blast of air. The sawdust being the lightest, it is blown over into a large, room-like box, while the pins, being heavier, fall into a bin below. After this they are spread out in trays, having sheets of zinc in their bottoms, which have been previously connected with one of the wires of an electric battery. The trays are then placed in a tank containing a solution of tin in muriatic acid, and the other wire of the battery is inserted in the solution. Electrical action immediately begins, and deposits metallic tin on the entire surface of each pin. They are then washed in a tank of water and put into other tumbling barrels with hot sawdust. When they have been dried and cleaned of the sawdust, as in the former instance, they are put into a large slowly-revolving copper lined tub, which is tilted at an angle of forty-five degrees. As this revolves the pins keep sliding down the smooth copper to the lower side. This constant rubbing against the tub and against each other polishes them.

"It was the practice formerly to allow pins of all lengths to become mixed in the different operations, and after polishing to separate them by a very ingenious machine; but it has been found more economical to keep each size to itself. From the

polishing tub the pins are carried to the 'sticker,' where they fall from a hopper on an inclined plane in which are a number of slits. The pins catch in these slits, and, hanging by their heads, slide down the incline to the apparatus which inserts them in the paper. As the number of pins in a row on the paper and the number of slits are the same, an entire row is stuck at once by an ingenious device which takes one pin from each slit and inserts them all at once in the two ridges which have been crimped in the paper by a wheel that holds it in place to receive the pins. At the same time this wheel crimps the paper it spaces the rows, so that when filled with pins the paper will fold up properly. This whole machine is so delicate in its action that a single bent, or otherwise imperfect pin, will cause the machine to stop feeding until the attendant removes it; yet its operation is so rapid that one machine will stick ninety thousand pins an hour. As the long strip of paper on which the pins are stuck comes from the machine it is cut into proper lengths by girls, who then fold and pack the papers in bundles ready for shipment."—Harry Platt, in the "Youth's Companion."

Needles were made by hand until 1826. Now by most ingenious machinery they are produced almost as cheaply as are pins. Seventy persons and marvelous machinery are employed in manufacturing a single needle!

Pneumatic Dispatch is one of the achievements of this century. In 1810 M. Medhurst published a work entitled "A New Method of Conveying Letters and Goods by Air." His proposal was to construct a closed tunnel, in which the carriages —the last of them provided with a piston fitting the tunnel—should be propelled by air forced in behind them. Vallance, of Brighton, in 1825, recommended as an improvement on this plan the exhaustion of air in the front. About 1835 Mr. Henry Pinkus, an American gentleman residing in England, patented a scheme for placing the carriages in open air, but connecting them below with a small tunnel, having a narrow slit above, with ingeniously constructed apparatus to render the tunnel temporarily air-tight notwithstanding the slit. Not much was done to carry out the patent, and Pinkus' scheme of what he called a pneumatic railway was considered as having failed, when, in 1840, Messrs. Clegg and Samuda brought forward a somewhat similar project under the name of the "Atmospheric Railway." An experimental fragment of line laid down near Wormwood Scrubs, just outside of London, on the Great Western Line, was successful, as was one designed for actual use from Kingstown to Dalkey, in Ireland, another between London and Croydon, and a third in South Devon; all, however, have been since abandoned. For passengers, at least, and to a great extent even for the transmission of letters, the railways of the ordinary type, on which steam is the impelling force, have triumphantly held their own against the innovation of the atmospheric or pneumatic rail-

way, and all that now remains of the latter method of propulsion are the pneumatic dispatch tubes, used for transmitting parcels to short distances. The first successful apparatus was designed by L. Clark and Varley, in London, in 1854. The tube was 200 yards long. The atmosphere pushed the carriers. In December, 1869, Messrs. Siemens laid tubes from the London General post-office to the Central telegraph station. Packages are sent by the force of the compressed air behind them. A speed of 130 miles an hour is possible. Pneumatic dispatch seems practicable for short distances—in long distances the waste of power is too great.

The pneumatic system is, however, being rapidly introduced for the transmission of parcels for short distances. During the last fifty years the system has been brought to great perfection in the European post-offices, and later in New York and Philadelphia. The first application to the conveyance of mails and parcels was made in 1863 by the Pneumatic Dispatch Company, of London, which constructed a line of D-shaped tube beneath the surface of the ground from the terminus of the Northwestern railway, at Euston, to the district post-office in Eversholt street, a distance of about 1,800 feet. The dimensions of the tube were two feet eight inches wide and the same in height. The carriages traveled at the rate of seventeen miles an hour. This experiment was so successful that a line was constructed from Euston to the general post-office, a distance of 14,214 feet, with the tubes four feet high and four feet six inches wide. Briefly stated, the system of pneumatic transmission consists of sending messages, or small parcels, by the pressure of the atmosphere, or the action of compressed air. A person who wishes to try the system for himself on a small scale may do so by putting a paper pellet in a glass tube. If he will put one end of the tube in his mouth he will find that when the air is forced into the tube the pellet will move away from him, while when it is exhausted it will move toward him. This is the simple principle of the pneumatic tube, which is used in the larger dry goods stores for the transmission of money between the cashier and the salesmen. It was not until about 1840 that the plan was put into practical operation, and its development upon a large scale has been slow, the way being led by Europe. The pneumatic tube service has already become enormous in the great cities of Europe and America. Not only are goods and money conveyed in the great stores, but underground tubes are in successful operation, and tubes across bridges, as between New York and Brooklyn, convey mails and merchandise with wonderful rapidity. The system is fast growing, and is destined to become general, and to take the places of telegraph, telephone and express for a large part of the daily business of city life.

The ancient, uncertain and wasteful method of harpooning whales is superseded by the new system of attacking the schools. The steamer

s a gun in her bows, from
the harpoon is fired. On
ng a whale a bomb explodes,
g the mammal instantaneously,
leveloping a gas which pre-
it from sinking. The system
ure, that it is very rarely that a
is lost.

e seismoscope, or seismometer
a wonderful instrument. It
connected with it an electric
and a magnet, and an auto-
photographing arrangement,
cessary for the proper measur-
the movements of the earth's
e. The earth's crust is in
nt unrest; quiet, even pulsa-
keep the ground almost con-
ly rising and falling, sometimes
g waves, sometimes in quiver-
remors, underneath our feet.
annot feel these movements
se our senses are not fine
h, but these wonderfully
l instruments, always on duty
e earthquake observatories,
aithful watch dogs, make their
nce quite plain, and accurately
l all earthquake disturbances.

undred years ago the shoemaker
to the farmhouse with bench
apstone, and made shoes for
amily. He sawed a block of
or maple as thick as the length
eg, and split and sharpened the
which he seasoned in a pan
e the fire. It took him a week
ake a bushel of shoe pegs.
cents will now buy as many
etter machine-made pegs, by a
ine invented by Joseph Walker,
18. The ancient shoemaker
ut a clumsy, ill-fitting shoe or
and "built" it. Now sole-leather is rolled through powerful rollers; the leather is cut by dies which shape several pieces at once, and a sewing machine brings the parts together, instead of the primitive waxed end. One man does fifty times as much by machinery now as then, and does it better. So of clothing; so of furniture. Frank Chase, of Waterville, Maine, years ago invented a machine simplifying the manufacture of shoes. A New England company purchased his invention for $100,000 cash and gave him $2,500 a year for life, provided he would do no more inventing. In a recent interview he bitterly regrets having made that contract. McKay's shoe-making machinery was developed in 1861. (See "Sewing Machine.") One hundred and twenty-eight different machines for shoe-making are recorded in the "Mechanical Dictionary."

The Tubular Lantern was invented in the sixties by John H. Irwin, Chicago, whose first suggestions were added to, and the lantern perfected by Joseph S. Dennis (1820), whose enterprise circulated all over the world this useful means of safely lighting dark places. Before its invention kerosene was tabooed in all situations of danger. The treacherous fluid was not allowed on a railway. Farmers would not permit it near their hay. But the invention of the Tubular brought kerosene into universal use, and renders it as safe as whale oil or lard oil, while the peculiar construction of the lantern gives far more light at far less expense. It is one of the most useful appliances in

modern life. Those who remember the ancient, awkward construction of perforated tin, with a candle sending out feeble rays of semi-darkness, or even the oil lantern in use before the advent of the Tubular, will rank it high among the modern inventions. It has no successful competitor in any part of the world.

So simple and common a device as an aquarium was never thought of until this century had half gone. Gold fish had indeed been kept in globes of glass, and the water so changed as to preserve the fish alive, but the aquarium is constructed on the principle that animal life gives out carbonic acid, and absorbs oxygen, while plant-life reverses the process, and thus imitates the plan of nature. Ward, in 1841, invented the "Wardian cases" or aquaria, in which plants and fishes are kept, and vegetable and animal life balance each other. Tanks of all sizes, public and private, are constructed, and thousands of homes enjoy the pleasure and receive the instruction imparted by these beautiful object-lessons of the action and inter-action of animal and vegetable life.

Celluloid is an ivory-like compound of paper immersed in sulphuric and nitric acids, which transforms it into nitro-cellulose. After washing and bleaching it is passed through a roller-mill, and mingled with camphor. It is a valuable substitute for bone or ivory. It softens at 176 degrees Fahrenheit, and is very inflammable. Thousands of useful and beautiful articles are made of this lately discovered substance.

Professor T. S. C. Lowe (1832) is one of the most prolific of inventors. In early life he began in aeronautics. In 1857-9 he devised methods of ascertaining locations without the use of the horizon or sight of the earth. His "Altimeter" enabled him, in balloon ascensions on cloudy days, to determine his whereabouts. He also perfected a method of rendering silk and other fabrics impervious to gas, so that an inflation would serve for several months. In 1861 he invented a portable hydrogen gas generator, which was transportable by wheels or ship, and which would inflate a balloon in an hour. His achievements during the civil war were brilliant, and rendered the government great service. Professor Lowe, prior to the opening of the war, had constructed a balloon that was by far the largest aerostat ever made, for it lifted more than sixteen tons when inflated. He made a memorable balloon trip from Cincinnati to determine the existence of a uniformly-moving eastward air current, no matter in what direction the surface currents are blowing, and he landed in South Carolina after a trip of eight hours, where he was regarded as a Federal spy and arrested, and thus became the first prisoner of war. During the civil war, amid the storm of battle, he rode serenely in the air and telegraphed from his aerial position the movements of the enemy to headquarters, while they honored him with their polite and delicate attentions in the form of shot and shell thrown by their long range rifle guns. (The French employed balloons in reconnaissance, in the

Franco-Prussian war.) Professor Lowe invented (1865) and patented (1867) the method of manufacturing artificial ice, in commercial quantities, by the liquefaction and expansion of gases. He also has discovered (1897) a process for the manufacture of ammonia direct from its elements, and thus again has interested himself in the work of his earlier years, the science of artificial ice making, for ammonia is used extensively in this business. It is makable in the warmest countries as cheaply as it naturally can be cut from frozen lakes or rivers. Iron molds are filled with water and suspended in vats of ammoniated water, which freezes the water into solid ice. The molds are suspended in hot water a brief time, and then the beautiful, transparent cakes are ready for use. Ether and other articles are used in the many processes by which this great luxury is brought within the reach of people in all climates. Cochrane, in his "Wonders of Modern Mechanism," says: "An ice machine with a pair of single-acting gas compressor pumps, and steam engine, with separators, gauges and connections; an ammonia condenser, with liquefying coils, etc.; system of tanks, ice molds, evaporating coils, wood grating and covers, cranes, thawing apparatus, agitating apparatus, distributing pipes, shafting, etc.; distilling and purifying system, consisting of a separator, purifier, distiller, and various tanks and filters; steam boiler plant, with pumps, etc.; water pumping system with pumps and pipes." Cold storage and refrigerating processes are closely connected with ice making. Nowadays, so perfect is the system of refrigerating that the most perishable articles of food may be carried to the antipodes without suffering any harm, or they may be preserved for years, to be taken from their cold storage room in as good order as they were put in it. It is said that the Greeks and Romans were able to make artificial ice. Walker, in 1782, Leslie, in 1810, and Harrison in 1857, patented processes for making ice artificially, but not of commercial value. In 1869-70 Professor Lowe refrigerated the first steamship for the transportation of foods of all kinds. The intricate machinery for producing this was in use for years in San Francisco, where it produced ten tons of ice daily. This invention has revolutionized the food supply of the world. In 1870 he originated the first practical gasoline gas machine; the first water wheel ever applied to such a machine. In 1871-2 he devised the production of steel directly from the ore, an invention which is now employed the world over in producing steel rails and steel plates. In 1872-3 he invented water gas. He patented the process in 1875. The invention is fast revolutionizing the gas industry of this country and Europe. At the present time seventy-five per cent. of the gas companies in the United States and Canada depend entirely for their success upon the invention of Professor Lowe. His system of producing what is commonly known as water gas has so cheapened the cost of production as to induce almost every gas com-

pany to employ his methods exclusively. He has just patented a new system of coke and gas manufacture that will as completely revolutionize the present methods as his water gas process revolutionized the old system. The first asbestos open-fire heater was his, and many devices for gas heating and gas cooking are the results of the action of his fertile brain. The mountain railway at Pasadena, California, is a monument to his ingenuity. It was the first, and is, so far, the only mountain railway in the world operated by large gas engines; also the first to employ water-power, which it does under a head of 1,400 feet. In perfecting this railway he originated many ingenious devices. This wonderful road was the first electric road to make a continuous climb from a mountain base to its summit. He has a system of aerial and submarine navigation long ago perfected, but not yet given to the world. This work can only hint at some of the achievements of a genius whose useful inventions and discoveries might fill a volume.

Hydraulic power is produced in various ways and is used in raising great weights, and in producing heavy pressure. Much of its adaptation is of modern origin. A teacup of water falling down a small pipe will produce a force equal to raising tons of weight. Elevators, lifts or hoists are often raised by hydraulic force.

Submarine blasting was resorted to first in attempts to raise the wreck of the "Royal George," and at Hell Gate, New York, in 1851. It is now extensively employed.

Roller skates have come within twenty years.

Adolph Heinrich Joseph Sutro, one of the great engineers of the century, was born in Aix-la-Chapelle, April 29, 1830. Died 1898-9. He reached America in 1850, and went to Nevada in 1860, and conceived the tunnel through the mountain near the famous Comstock lode. He began the work in 1869. In 1879 the tunnel was completed, and each mining company paid two dollars a ton for all ore passing through the tunnel. This made Mr. Sutro a multimillionaire, and the world has been blessed by the many benefactions of the wealthy and generous engineer. He died in 1898.

Among the useful inventions are the rock-borers, which pierce solid granite. "Burleigh's Rock Drill," an American invention, is among the best; invented by Charles Burleigh, of Massachusetts. Another is the Diamond Drill, which is pointed by the black diamond of Brazil, which was first discovered in 1842. It is known as carbonado. After boring through hundreds of feet of the hardest rock, it is unworn, and as it does not cleave or split, it is wonderfully durable. It is now used generally in tunnelling for mines or water. The use of this diamond as a drill was first suggested by Hermann, in 1854. Quarrying machines of many kinds, and of great efficiency, are now in use, all of recent origin. (See "Travel.")

The century has been distinguished in this country by enormous

THE FERRIS WHEEL.

"Over two hundred and fifty feet in diameter with thirty-six carriages, each seating forty persons."

A GROUP OF WINDMILLS

governmental land grants, to promote internal improvements in those localities where the traffic would not justify the building of railways. The Illinois Central received a strip of land twelve miles wide, running the whole length of Illinois; the Northern Pacific received 47,000,000 acres; the Atlantic and Pacific, 42,000,000; the Union Pacific, 13,000,000, etc.

One characteristic of the century, conducive to health and comfort, is the means of supplying water for domestic use. The Holly system and other methods are employed, that need not be here described. water may be conveyed to all houses, and a continual supply given to all. Anciently, elaborate baths, like those of Caracalla, afforded luxury to the rich, but now hot and cold water are found distributed in all cities and towns, and public works are established that can send water to every home. One of the great sources of the improved sanitary conditions of modern times is the distribution of water among the people.

Alfred Guthrie, grandson of the discoverer of chloroform (1805-1882), designed the hydraulic works of the Illinois and Michigan canal, the first steam canal feeder ever made, and which was operated twenty-three years, or until the canal was deepened to a gravity flow in 1871. But his title to the rank of benefactor to his race and age is the Steamboat Inspection law of 1852. In the fall of 1851 a steamboat explosion at New Orleans so impressed him that he traveled up and down the Mississippi, and carefully inspected the methods and customs in vogue, and formulated a bill placing all steamboats under United States government inspection. In spite of the opposition of steamboat interests and of the population along the great rivers the bill became a law, and changed steamboat navigation from the most hazardous to the least dangerous of all modes of travel. Report of the United States Supervising Inspector General of Steamboats in 1880, says: "In the valley of the Mississippi, and in the Gulf of Mexico, up to the year 1849, there were 1,656 steamboats, of which number there were lost by sinking 419; fire, 104; explosions, 168; collisions, 45; total, 736. There were killed and wounded during the same period, from explosions alone, 4,660 persons. No data are given of casualties by burning, sinking, wrecks or collisions." The report of the same official in 1882 (referring to a table of statistics, here omitted) says: "Of the foregoing lives lost but fifty-six are reported as those of passengers, the remainder being of employes of the steamers, many of such losing their lives through carelessness begot by familiarity with dangerous duties." In 1882, number of passengers carried, 354,000,000; number of lives lost, including passengers and crews, 205; number of steamers running, 5,117; loss of life, only one to each 1,726,287 persons carried. That the steamboat laws have been as beneficial as the framers of them anticipated, may be justly claimed by comparing the percentage of loss of the present year with that of the year 1851, the year preceding the enactment of the

first really efficient law for the protection of life on steam vessels. In that year the number of passengers carried was 39,204,691; the number of lives lost, 700; number of steamers running, 1,390; loss of life, one to each 55,714 persons carried."

STOCK-YARDS.—One of the products of the century is the stock-yard, a place where cattle can be centered from the great stock-raising sections of the United States. There are many of these establishments, but the principal one, that in Chicago, Illinois, will indicate the rest. To establish this market, with its unequaled facilities, cost millions of dollars, and, as a result of this great expenditure, no other place affords the accommodations which can be had at this point. One yardage charge, covering the entire time stock remains on sale, and the charge for feed made against the stock by this company, are all the charges which are made. From these sources comes the revenue required to cover all expenses pertaining to the stock-yards—such as construction, repairs, cost of hay, corn, oats, weighing of live stock, lake-water system, taxes, fuel, gas, electric lights, tools, lost stock, yard cleaning, labor of 1,000 employes, current expenses, such as attorney's fees, insurance, books, stationery, printing, salaries of officers, agents and clerical force, and of the police and fire departments; interest on bonds and capital invested, all of which expenditures are incurred for the maintenance of this market, and accrue to the direct benefit of its patronage and the shippers of live stock. A regular cash deposit fund of $300,000 is also furnished to the National Live Stock Bank of the Union Stock Yards, to insure the payment of live stock shippers' freight expense bills. To this establishment are shipped every year more than 200,000 carloads of animals for slaughter and sale, and the total numbers of the cattle thus brought together will average from 10,000,000 to 15,000,000 head.

One of the greatest conveniences and even luxuries in modern life, especially to mariners, miners, explorers, and those living remote from the world's markets is the process of canning, or as the British call it "tinning" fruits, meats, etc. Every kind of fruit and meat is hermetically sealed and placed in portable shape for transportation to all parts of the world, and thus prepared will keep fresh for use for months. Soups, fowls, fish, fruit, vegetables, in fact every article of food is thus prepared, enabling the residents of the remotest corners of the earth to procure what a half century ago was impossible away from the great centers of population. The process was introduced by Francis Appert, in Paris, in 1810, who preserved meats in glass vessels, in a bath of chloride of calcium. The delicious salmon of the Pacific, the cattle of the west and of South America, all kinds of vegetables and animal food are transportable to all parts of the world by means of this process, a business unknown long after the century had begun. And it enables all countries to export their surplus to remote regions,

so that famine is rendered less and less possible as the means of transportation are increased.

Condensed milk, the concentrated essence of the cow, the friend of miner, explorer, sailor, soldier, which goes into all lands and on all seas, was invented in 1849, by Gail Borden (1801-1874), in the neighborhood of New York.

The elevator, as it is called in this country, or "lift," or "hoist" in Great Britain, is a hoisting machine for persons, goods, or material in large hotels, factories, stores and tenement houses. It is moved by water, steam or electricity.

The air-engine, caloric-engine: An engine which has for its moving power heated air, that is, which employs air, like steam in a steam-engine, as a medium for transforming heat into mechanical energy. The best known air-engines have been those of the Rev. Dr. Stirling, in 1816, Capt. Ericsson in 1833, and Philander Shaw in 1867.

The turbine wheel was invented by Benoit Fourneyron (1802-1867) in 1823, and the first one was made in 1827. Improvements were made in 1837 and 1855. In the original form the water enters at the center, and, diverging from it in every direction, then enters all the buckets simultaneously, and passes off at the external circumference of the wheel. The term was originally applied to horizontal water-wheels, the revolution of which is due to the pressure derived from falling water, but it is now applied generally to any wheel driven by water escaping through small orifices subject to such pressure. It now is greatly increased in power, and costs one-fifth as much as at first.

The inventor of the Moncky (not monkey) wrench was Charles Moncky, who sold his invention for $2,000, and who in 1895 was living in the house built with the absurdly small amount which he received for his invaluable invention.

Roofing machines for covering roofs with felt, tar, etc., were introduced by Haven, in 1857; Davis, 1858; Pomeroy and Allen, 1859; Anderson, 1861, etc.

Theodore Ruggles Timby (Dover, N. Y., 1822), when only fourteen years old made a model of a floating dry-dock, and at nineteen he exhibited to the government a design of an iron revolving battery. Later he patented his idea, and the builders of the Monitor paid him a royalty of $5,000 for each turret they constructed.

The riveting machine does the work of twelve men.

Road rollers and scrapers accomplish by steam the work of many hands.

Roman cement was the invention of Parker, in London, in 1812.

The first iron safe was built by Richard Scott in 1801. Others followed by Marr in 1834, Chubb in 1835, and Herring and others made improvements later. Iron burglar-proof and fire-proof safes, with time and other locks, were built by Yale, Corbin, Sargents, Marvin, Herring, and others. The safes and locks are among the great modern inventions of the century. Yale's locks are in use all over the world.

In 1893 G. Eiffel (1843) built the famous "Eiffel Tower" in Paris.

M. L. Brunel (1769-1849), the inventor of the Thames tunnel, also invented machinery for making hoisting stocks, shoe-making machines, veneer saws, nail-making machines, paper-ruling machines, gas engines, and other ingenious and useful machines.

The first section of the London underground railroad was opened in 1863.

Deep sea thermometers are now built, the invention of Negretti and Zambra, that reveal the temperature of the deepest soundings.

The meteorograph registers the height of the barometer and thermometer. It is the invention of Professor Hough.

The chronograph or chronoscope measures the velocities of projectiles.

The driven well was first used by the French army in China, in 1856.

The heliograph was invented by H. C. Mance for telegraphing by means of the sun's rays. It is composed of a circular mirror, varying in diameter for field or fixed operations. This mirror revolves on a horizontal axis, and is adjusted to the required angle of incidence with the sun by a telescopic rod, and the rays can be directed to any point with the utmost precision. The Morse system of dashes and dots is adopted, and the signals can be read in ordinary weather, without the aid of field glasses, at a distance of fifty miles.

The heliostat is an instrument invented by Gauss, in 1821, by means of which the rays of the sun can be flashed to great distances. It consists of an adjustable mirror or reflector, worked in connection with a combination of telescopes, and is now used in all trigonometrical surveys. By its aid triangles, with sides over one hundred miles in length, can be measured. Drummond's heliostat consists of an equatorial, revolving on its polar axis, so that the sun, when once accurately in the focus of the telescope, continues steadily fixed there.

THE SAND BLAST.—One of the most ingenious and practicable means of glass cutting has been devised in what is known as the sand blast. Two young fellows were resting in the shade, in the famous Garden of the Gods, in Colorado, and were endeavoring to account for the eccentric shapes of the sandstone rocks around them. Observing that they seemed unworn on one side, the windward of the prevailing winds, and sculptured only where the wind blew the sand against them, they concluded that the wind-blown sand had done the work. Reaching their Chicago home, they placed a pane of glass under their window one night, and caused a stream of sand to trickle and fall upon it. To their surprise, in the morning they found that the sand had ground the general surface of the glass, and had left unaffected the spots where their greasy fingers had rested. This suggested the sand blast, and drawing a pattern on glass with wax, they directed a stream of sand on it, and washing away the wax, they saw the pattern beautifully delineated, while the uncovered glass was

ground. The sand-blast process was in use before this, but this incident shows how it was re-discovered. Glass is now "cut" very cheaply by sand wind-blown or steam-blown with great force against it, and the labor of many days and workmen is performed by machinery at comparatively small cost. Stone is also cut in the same way. Stencils are laid on the stone, and the sand cuts away the surrounding material, and leaves the letters or patterns. The sand blast is one of the many minor inventions of which the Nineteenth Century is fruitful. It has been thought that the hard Egyptian monuments may have been sculptured by the ancients by some such process.

The thermostat is an ingenious gauge to regulate the heat of furnaces. It was first introduced into England by Cummings, in 1816, and was improved by Doctor Ure, in 1830; a number of modifications have recently been added, notably by Powers, Chicago.

Parchment paper horseshoes are made of thin layers of paper glued together with a paste of chromic size, ammonium oxide, or some substance which does not become brittle and dry, and can be nailed or glued on. They are also made of paper pulp stamped or cut into shape, chalk, clay or sand, lac, turpentine, linseed oil, etc., being added to the pulp. The bottoms are roughened to prevent slipping, and the shoes are light, tough and elastic.

"Volapuk," invented in the latter part of the century, is an attempt to create a universal language. It was originated by Johann Maria Schleyer in 1870. Each letter has but one sound, and all words are written as pronounced, and pronounced as written. The words are selected from most European languages. Schleyer was acquainted with fifty languages. There are several newspapers devoted to the dissemination of Volapuk. The new scheme is thus satirized:

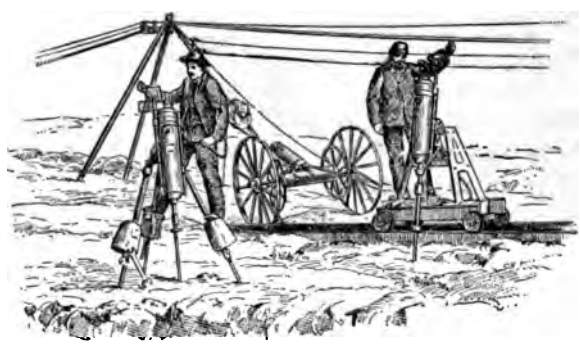
Take a teaspoonful of English,
  A modicum of Dutch,
Of Italian just a trifle,
  And of Gaelic not so much;
Some Russian and Egyptian,
  Add then unto the whole,
With just enough flavor
  Of the lingo of the Pole.

Some Cingalese and Hottentot,
  A soupcon, too, of French,
Of native Scandinavian
  A pretty thorough drench;
Hungarian and Syriac,
  A pinch of Japanese,
With just enough Ojibbeway
  And Turkish as you please.

Now stir it gently, boil it well,
  And if you've decent luck,
The ultimate residuum
  You'll find is Volapuk.

To chronicle the miscellaneous inventions of secondary and yet of real value, and of improvements on older inventions that amount to inventions, that have added to the convenience and comfort of mankind during the century, would be to record thousands of distinct illustrations of human ingenuity. Such are the actinometer for measuring the sun's rays, by J. F. Herschel, 1825; the addresser, which prints the address on newspaper wrappers, by Moeser, 1851, on which twenty

patents have been issued: fifty patents of air and hydraulic elevators since the first crude suggestion; centrifugal pump by Appold, 1848; ship ventilators, Somers, 1865; broom-making machines, carpet sweepers, etc. Mrs. Samuel Williston, East Hampton, Massachusetts, in 1826 made the first cloth-covered buttons, and she and her husband devised machinery for manufacturing them, from which they realized an enormous fortune. Ossian Guthrie (1826) is the inventor of a device for preserving ice. The normal temperature of ice is 32 degrees Fahrenheit, but it will absorb any degree of cold below that temperature, and retain it if protected. Mr. Guthrie's device consists of automatic ventilators and thermometers so arranged as to open or close as the outside temperature rises or falls. In winter cold air enters, and in summer the air is admitted above the ceiling, and cooled by compressed air, which operates the ventilators, and is let on or shut off by the operations of the thermometers. (See "Geology.")



ELECTRIC DRILLS.

Domestic and other inventions and improvements are innumerable, such as the "Pullman Kitchen, out of the Window," by Mrs. Dexter, of Pasadena, California, in 1899. It is an ingenious device for those who live in rooms and who wish to get meals therein, but who wish at the same time to avoid filling their rooms with the odors from the kitchen. It is a galvanized iron box eighteen inches deep and thirty or thirty-six high, set right out the window and screwed to the sill. It has an air shaft and a number of ventilating holes covered with screen. The cooking from gas or oil is done right in the "Pullman Kitchen" and all odors and smoke pass out of the ventilators, and the concern is entirely fire proof.

Grain mills: The Hungarian process of grinding wheat by rolls is a recent invention, introduced about 1840. In 188[illegible] William D[illegible] Gray, Milwaukee, improved the rolls by making the ribs abrupt on one side, and, 1880, John Stevens, Neenah, Wisconsin, patented rolls formed of grooves, with round divided ridges. Flour ground by rollers is an invention of the last half of the century and is a great advance in the mill-stone process.

Many new processes of mining, grinding and smelting gold and silver have been and are continually being discovered by the ingenuity of modern seekers of the precious metals.

Filters of many kinds for the puri-

of drinking water, some
or dwelling house use, others
e; to clarify the drinking
f a community, are in use, all
resent century.
ines for making paper bags
1852), for which the "Me-
l Directory" gives seventy-
tents; baling machines; the
mould, which shapes glass
invented by Ricketts, in
d, in 1822; more than 600
aking machines; fire-proof
'Kyanized" by creosote, etc.,
1832; Burnettized, invented
nett, in 1837; blotting paper,
sts, many methods of cold
in houses, cars and ships;
-presses—the manifold letter
in 1806, by Wedgewood;
g and washing machines;
bed for invalids, Clarke,
evators for grain; machinery
d making; baking powder;
pointing machines, Hawkins
ordan, 1823; dredging, ice-
tenoning machines, bath
in houses, button machines,
vaporators for salt-making,
invented since 1842; brine
1824; machine for sheep-
g, needles made by machin-
ickel-plating, paper boxes,
aper cloth, 1843; machinery
ery manufacture, buttons,
tacks, hooks and eyes; hat
, paper collars, Cantelo and
n, 1833, and muslin center,
aper outsides, Walter Hunt,
corrugated iron roofs, first
London, 1840; water mains,
king, machinery in cities,
ire cloth, which has been
s fine as 260 parallel threads
to the inch; water gas by Cruickshanks, in 1839; files, screws; refrigerator cars; first used in 1867; the "Fairbank Scales," a compound lever weighing scale, by Thaddeus (1796-1886), and Erastus (1792-1864), Fairbank in St. Johnsbury, Vermont, in 1831. There are 400 sizes. For weighing heavy bodies they are unrivaled. In 1872 Emmons invented a scale worked on hydrostatic principles. The Torsion Balance (scales), with points instead of knife edges, was introduced by F. A. Roeder and A. Springer, in 1882.

The Argand lamp, that increases the light of the oil by increasing the consumption of oxygen, invented by Aimee Argand, in France (1755-1803), though invented the last century, was not in use until 1830; the Student's lamp, by C. A. Kleeman, in 1863, afterward improved by C. F. A. Hinrich; the Hitchcock (Robert) lamp, 1868, to burn lard oil without a chimney, are useful inventions. Round wicks and mineral wicks, and lamps of many kinds, such as the Rochester Burner, have given great comfort to those who must consume the "midnight oil."

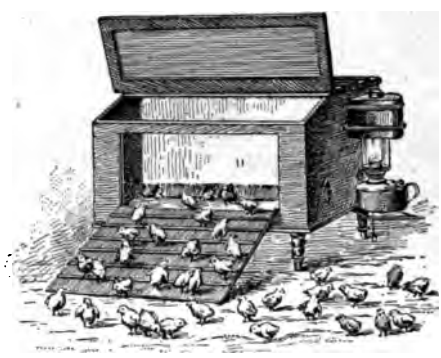
James Bowie (1796-1830), invented the famous bowie-knife, about 1827. He perished in the massacre of the Alamo, March 6, 1836, when 3,000 Mexicans slaughtered 150 Texans. The monument to their memory has this inscription, "Thermopylæ had her messenger of defeat; the Alamo had none."

The number of tools and implements to render work easier and better, in the various trades and callings, is literally legion. The many bits,

planes and other tools for carpenters, including the circular saw, number more than 300 according to the Mechanical Dictionary; blacksmiths, shoemakers, bookbinders, bakers, masons (300); other trades and callings numbering thousands of recent inventions in all.

Besides these, more than 400 domestic appliances, such as improved coffee pots and artifices to expediate and lighten domestic labor—furnaces, steam and hot water for warming houses, laundry dryers and other devices, incubators, etc., have been recently invented.

While men thought steam was their final achievement in producing motive power, until electricity came, and were absolutely certain that no further progress was possible when the lightning was caught and harnessed, lo, man's inventive genius utilized the elusive and impalpable atmosphere, and caught, compressed and harnessed the air, and set it to work. The latest force that man has utilized is compressed air. Not the wind's unseen currents whose motion is guided to impel machinery, but just plain, every-day air, taken from close to the ground, compressed by Titan hands to a hundredth part of its ordinary volume, so it can be made to turn wheels and do the work for which steam and electricity have had the monopoly since the horse was driven from the field. The condensed air-motor is going to conquer the whole short line transportation world, for the foremost engineers in this country agree that compressed air will soon become the principal secondary power, wherever large powers are to be used or transmitted for reasonably short distances, on account of its great superiority to electricity in point of economy, efficiency and safety.



AN INCUBATOR.

The Hardie air-motor, besides being the least dangerous power for transportation, costs one-third less than even the trolley system to operate, while there is a much greater saving in the cost of maintenance. It is practically noiseless. The system does not require the tearing up of streets. The motors are convenient to operate. Finally, the cars are independent, so that an accident to one will not block up the whole line. "Each car of the ordinary size is planned to carry fifty-one cubic feet of air at a pressure of 2,000 pounds, which condenses it so that when released it occupies 133 times the space it does in the bottles. The bottles are long tubes of soft Mannesman steel, a new product, and are nine inches in diameter. Placed under the floor of the cars as well as under the seats, they are all connected. The compressed air

A LIFE-SAVING STATION.

"On all the coasts of all Christian countries, trained men and apparatus are stationed."

AN HEROIC CREW.

"The life-saving service is another of the many succors devised for the safety of sea-farers."

it to work practically in the way as is steam in a locomo- It is, however, first passed gh a reducing valve which s the pressure on it to about pounds, and then reheated to it double the elasticity it would wise have. Then it is ready let into the cylinder and do its in whirling the wheels. The engine under the cars is a very simplified locomotive and has al devices for controlling and erating, without which air could be used as motive power. A form of air brake is put to use, the inventors say will stop going at a given rate in less than any known device. The can be refilled at the power- within a minute, and are then for another run. The condens- pparatus used in the power- is simple, but the air must be nsed and then cooled three suc- e times before it reaches the red conditions. It is estimated he cost of equipping a line with ir-motor system is about one- the cost of the underground ic system, and about twenty- er cent. less than the trolley n. The probability is not re- that compressed air may at no t day dethrone electricity as a e power, as electricity is at this g dethroning steam.

was first liquefied in 1877 by l Pictet, of Geneva, and is now becoming a motive power to all human uses. The Keeley was for years supposed to be greatest of mechanical inven- but at Keeley's death it was discovered to be a stupendous fraud and swindle.

Henry Goldberg, of Chicago, in 1899, invented the arithmachine, which not only adds but subtracts, multiplies and divides numbers instantly. A box of bright aluminum, four and a half inches long, and one and a half wide, and three-quarters of an inch high, it is small enough to appear insignificant when picked up and slid, without ceremony, into coat or vest pocket. By means of it columns of numbers can be added more quickly than the figures can be written, and it may be depended upon as absolutely correct. When held between the palms of the hands the arithmachine is entirely hidden from view. In 1898 a wonderful book-keeping machine was invented in New York, which "promises to revolutionize methods of recording a large part of bank accounts. It is the invention of Leicester Allen, and was designed by that genius in mechanics at the request of the bank's president, Charles E. Sprague. There are really three machines, one to keep a record of the deposits of men patrons, another for women depositors, and a third for keeping accounts of the drafts on the bank. The teller sits at a table with the apparatus at his right hand. The depositor's bank book is placed in the machine and the amount pulled forward from a keyboard of figures something like the keyboard of the typewriting machine. A lever is pressed, the mechanism buzzes, and the sum deposited is printed in the book and also on a tape in the box above the machine. Another cylin-

der is automatically set in motion and the new amount is added to the total of the bank's deposits since its foundation. It is practically impossible for the machine to err. If a mistake be made by the teller the mechanism refuses to work. At the end of any day's business a balance may be struck in a few minutes and the figures must always be correct. The machines are placed in a sealed glass case and is open to the view. By a simple glance at the totals the officials of the institution can tell just how the bank stands with its 70,000 depositors."

Doctor Bruce Miller, in 1899, was the inventor of an automaton orchestra of life-size figures which could produce the same result that living flesh and blood musicians produced in an orchestra, blowing through their several instruments. The present orchestra of Doctor Miller is composed of twelve young women, figures, of course, and dressed up as their breathing sisters would be were they in an orchestra. Each young woman plays a certain instrument, the automatic orchestra devised by Doctor Miller comprising the following reed, string and brass pieces: Second violin, clarionet, piccolo, flute, trombone, metaphone, bass violin, cymbals, triangle, bass drum and snare drum. The twelfth lay figure is the conductor. The machine is twenty-five feet in length, twelve in width, and twelve and one-half in height. Its weight is nearly 3,500 pounds. Nearly one and one-half miles of composition lead and tin and rubber tubing has been utilized in the machine. There are besides 3,000 bellows and 4,000 valves.

During 1898 more discoveries were made pertaining to the nature of air than in all the years of the past. In a work like this only the barest reference can be made to discoveries that will have vast scientific results. Lord Rayleigh, in 1895, and Professor Ramsey, in 1896, found argon and hebium, and in 1898 Krypton, neon, metargon, monium, terrestrial coronium, xenon, therion, and polonium were discovered. Ozone was commercially produced In 1882 it was liquefied by Hautefeuille and Chappius. In almost every instance of the discovery of a new element the gas has been liquefied. In fact, the liquefaction of some of the gases made possible the discovery of other gases. Professor Dewar has been most successful in liquefying various substances. Olszweski liquefied nitrogen gas, in 1872. He reduced his gas to so low a temperature that he actually froze it. He also liquefied argon. It is thought that in his hydrogen experiments he must have reached minus 243 degrees centigrade. Minus 273 degrees centigrade is supposed by scientists to be absolute zero—that is, the temperature of interstellar space.

Perhaps none of these discoveries is quite as interesting to Americans as that of the new gas which Charles F. Brush brought to light in Cleveland. This gas, named etherion, constituent of the atmosphere, seems to be allied closely to ether itself. Mr. Brush has proved that its conductivity of heat, even when mixed with a large excess of other gases, is some-

thing like a hundred times that of hydrogen, the best gaseous conductor heretofore known.

These recent discoveries will develop great things in the realm of chemistry.

The chemical which Thomas A. Edison has been able to explode merely by shouting at it, is chloride of nitrogen. The inventor made but a small quantity for experimenting purposes. By varying the proportion of its constituents, he succeeded in producing it in so nearly a gaseous form that the slightest noise would be sufficient to complete the change. Professor McKay also produced it in so unstable a condition that small quantities placed about the room brought about the suicide (?) of some flies which rustled their wings in too close proximity to it.

The utilization of waste, or the manufacture of "by-products," is one of the triumphs of the century. Steel manufactories are producing cement from the pig-iron slag, formerly worthless. Among valuable articles extorted from what, until recently, was thrown away are buttons from blood, wood alcohol from molasses, fuel from half-digested food, paving bricks from garbage, oleomargarine from fat, silk from wood fiber, rubber battleship sheathing, and oil from corn, wrapping paper from cane, white paper from potato vines, brown paper from stable straw, paper from cotton, from sage brush and from the undigested food of a beef, knife handles and comb backs from horns, jelly and candy from hoofs, imitation ivory from white hoofs, imitation horn from black hoofs, handles and piano keys and dice from bone, glue, gelatine and neat's foot oil, and imitation whalebone from sinews, felt from slaughter-house refuse, curled hair from tail tufts, plaster from hair, brushes from hog bristles, putty, snuff and lard cases from bladders, window weights from tin cans, prussiate of potash from shoe uppers, concrete slabs from garbage, acids from plum and peach pits, jellies and champagne from apple cores, carbonic acid gas from beer, soft soap from Indian maize, fertilizer from waste, etc. A good steer will cost a farmer $20.00 to raise. The packer pays him $35 00 for the animal, which makes his profit $15.00, and the investment of the packer $35.00. From the meats and compounds of meat, $40.00; from the hide, hair, horns and hoofs, $25.00; from the fats, blood, sinews and bones, $15.00; from all other waste, $15.00, or $45.00 received from the by-products and $40.00 from the meat, a total of $85.00 on an investment of $35.00, or a gross profit of $50.00, from which is to be deducted all the charges for freights, agents, plant, offices, etc., leaving the packer's net profit somewhere in the neighborhood, it is said, of $10.00. The by-products, formerly wasted, are worth more than the beef.

Useless exercise of ingenuity has often been displayed in producing curiosities of invention, such as J. N. Maelzel's (1772-1838) automaton trumpeter, which executed tunes; his panharmonica, a band of forty-two musicians, for which Beethoven composed his battle symphony; a

speaking machine exhibited before the American Philosophical Society, in 1843, by Reale, etc. Robert Howdin invented an automatic nightingale, which not only wonderfully imitated the song of the feathered vocalist, but hopped from branch to branch, like the living bird.

Charles Babbage (1791-1871) constructed a marvelous calculating machine (1820), which should substitute mechanism for man. It calculated astronomical, logarithmic, navigation tables, tables of powers, and products of numbers. It integrated equations of finite differences rapidly, and corrected accidental errors, and printed all its calculations. It cost the inventor years of labor, and some $85,000 of money. Babbage subsequently constructed another machine, which he called a "difference engine" (described in the Edinburgh Review, July, 1834), and similar ones were built by George and Edward Scheutz, father and son, completed in 1853. These three machines were undoubtedly the greatest pieces of mechanism ever produced. Among inventors are James Bogardus (1800-1874), Matthew Boulton (1728-1809), A. L. Breguet (1747-1823), A. E. Dolbear (1837), Ed. Manard (1813-1891), Jacob Perkins (1766-1849) Nathan Reed (1759-1849), inventor of cut nails with heads, William Sturgeon (1783-1850).

Some of the results of modern inventiveness are exhibited in the Maine "Novelty Mills," where they cut up logs into spools, toothpicks, berry baskets and all sorts of things that are useful and inexpensive. One remarkable feature of the "novelty mills," is the manufacture of veneer goods. The machinery is of recent invention and performs wonders. Even the sawdust is saved and sold by the pound. It is molded into forms of beauty and used to decorate the gorgeous office buildings and "palatial" residences of the metropolis. There are several mills which can turn out millions of toothpicks every day, and millions of the wooden skewers that are used by butchers. A single factory sends to market 50,000,000 skewers and 200,000,000 toothpicks every month. The manufacture of spools is also a great industry. They are turned out by the hundreds of millions and shipped to all parts of the world. It is said that a great thread company manufactures 5,000,000,000 yards of thread every year, and the spools upon which it is wound come from a single mill. Checkers, chessmen, wooden sleds, bicycle rims, bicycle stands, and all sorts of wooden toys and trinkets are made in the same factories. But the "slicer" is the most curious and useful of all the new inventions for working up the birch logs of Maine, and its products are seen in every household and in every grocery and butcher shop in the United States. When we purchase a pound of butter or a quart of berries or a basket of grapes, we take them home in a dish made of thin wood. Ten years ago they were unknown. The invention of the "slicer" made them possible, and now millions upon millions of these useful receptacles are manufactured in the "novelty mills" of

ıe same mills turn out a sim-
ır of fruit baskets. When
ve pounds of grapes the
hrown in, and sometimes
er how it happens that no
made. A few years ago
re required to return the
the grocery and were given
The grocer tied them to-
unches and sent them back
eyard. He also collected
berry boxes and returned
e farmers to be used again,
or six times before they
plished their destiny; but
the grape baskets and the
es go into the woodbox,
feed the fire, because the
as made their manufacture
d so cheap that it doesn't
ıd them back. They use
ut birch logs which are
for other purposes. After
re cut and barked in the
y are shipped to the mills
ıd then boiled in hot water
d for twenty-four hours.
ss softens the fiber so that
split and makes it more
l pliable. While they are
he logs are carried by a
wmills with broad and keen
les, some of them several
and very sharp. As the
vly shoves the log toward
edge there is a sudden
vide, thin ribbon of wood
ver the knife, while the
ed back and placed in posi-
ı second operation. This
sometimes two or three
eighteen or twenty feet
not more than a quarter,
nes a sixteenth of an inch
thick. As it falls from the log it is laid upon a pile of its sisters, and then carried on a tram into the next room to another set of knives, which cuts it into proper lengths for baskets, boxes and crates. Then it passes on through another set of ingenious machinery, which bends and creases it into the proper shapes for berry boxes, grape baskets, peach baskets, butter trays, and the various purposes for which it is used. It is next taken in hand by quick-fingered girls, who fasten the slips together in the shapes desired with little clasps of tin, or small tacks, but most of the work is done by machinery.

There is a curious apparatus known as a "stapling machine," which is fed with a coil of copper wire, and forms staple after staple, which it thrusts into the wood, clinches and cuts off faster than the human mind can count them. A girl stands before the machine and holds the box or the crate so that the machine can get at it, and it will fasten boxes and baskets as fast as she can handle them. Sometimes expert operators turn out 4,000 and 5,000 baskets and berry boxes a day.

The berry boxes and the grape and peach baskets are sold by the thousand, and cost from a fraction of a cent up to two or three cents each for the largest ones. The wooden plates that you take to picnics can be turned out for fifty or sixty cents a thousand. Orange and lemon crates, which are shipped to Florida and California, are worth about ten cents each. Butter dishes and other wooden trays sell from

twenty-five cents to one dollar a thousand, and they run up into the millions every year. Nothing like this industry can be found in any other part of the world. It is unique and peculiar to the state of Maine. —W. E. Curtis, in Chicago Record.

The returns that small inventions have made to their authors are quite surprising. Says the British Patent Record: "The inventor of the roller skate made $1,000,000. The gimlet-pointed screw has been responsible for more wealth than most silver mines. Five hundred thousand dollars in first-class securities would not represent the fortune made by the man who first thought of copper tips to children's shoes. Even a little thing like the common needle threader is worth $10,000 a year to its owner, while the 'return ball' —a wooden ball fastened on a piece of elastic—yields $50,000 per annum; this is only one of many profitable toys. We may mention the 'dancing Jim Crow,' which produces $60,000 a year; the 'wheel of life,' worth in all full $500,000; the walking figure, 'John Gilpin,' and the 'chameleon top.' The sale of the last-named toy has been enormous, and the profits also enormous. Indeed the 'chameleon top,' as a profitable invention, has probably excelled any one discovery in modern times, however valuable and important this may have been. The man who discovered that a candle, if tapered at the end, would stick firmly into its socket patented the idea and afterward founded the largest candle factory in the world. Might not any one have thought of this simple device? Out of the millions who own umbrellas, how many realize that these unfortunately indispensable articles represent wealth untold! The frame, the cover, the materials used, all are the result of numberless experiments and patents. An umbrella years ago used to be made of whalebone and gingham. It weighed as much as a portmanteau. Alpaca was substituted for gingham, then silk for alpaca. Each change meant a fortune to the inventor who brought it about. For a long time the ribs were solid; then Samuel Fox arose, took the umbrella, and cut grooves along its ribs. He designed the "patent paragon frame," and lived to see his invention used universally. At the death of Samuel Fox, his heir benefited to the extent of $895,000—the residue of a total profit of at least $2,500,000.

Experiments had been frequently made to utilize the web of spiders, but it was not until 1899 that the French military balloonists bred and tamed spiders to yield fibers for their balloon cords. About a dozen tame spiders furnish the fibers to make a thread. The spiders are placed in a machine and the fiber is drawn out automatically, a certain length at a time. These fibers are united in a thread, and these threads are spun into cords for the balloons, which for their weight are much stronger than silk. Several species of the insect are adapted for this domestication, but the most promising is the "Halaba," or silk spider, of Madagascar.

The improvement in the details of banks and banking has been

great. Buildings, and all sorts of safes and vaults have been rendered more and more impervious to the assaults of the burglar—though it must be acknowledged that his ingenuity has so kept step with the safe-maker that it has come to be confessed by the banker that such a thing as a burglar-proof lock is impossible. Electricity is able to drive a wire through solid steel of any thickness, so that the time-lock, which even the owner can only open at the moment to which it is set, is of little value when the safe-cracker can drive an electric bolt into the center of it in a few minutes. It has been discovered, however, that a thin coat of steel is just as good as a thick one to protect the safe; and the last method of protection is to have the inside of the safe or vault so charged that if touched by a steel tool it will ring a gong and bring the watchman, and summon the patrol to the door, before the thief can reach the treasure he is after.

Among the valuable institutions created in the century are postal savings, and school savings banks. Postal savings are the small deposits of the poor, of which the government takes charge, giving security to depositors. They are successfully conducted in Europe, and are soon to be in operation in this country. School savings were inaugurated in Ghent, in 1866, and are most successful in Belgium. In Austria-Hungary, France and Great Britain they are firmly established. Public thought in Great Britain has crystallized into a sentiment that requires a savings bank within the reach of every man, woman and child in the realm, and that children must be encouraged and brought to form habits of saving; hence the whole country is dotted with savings banks, postal banks and penny banks, all under the fostering care of the government. Depositors in the school and postal savings banks of France and Great Britain run no risk of losing their savings; they know that their money is safely invested in English consols or French rentes, and that they can withdraw it at any time or receive an interest-bearing bond. With similar opportunities the children of this country would soon save millions of dollars, gain experience and acquire habits of more value than the money saved.

In spite of disadvantages, lack of information touching the benefits of school banks and want of facilities which postal banks afford, the system has been successfully inaugurated in this country, mainly in Pennsylvania, New York and New Jersey, where mutual savings banks afford reasonably safe depositories for savings. Already Congress has approved a bill establishing postal savings banks, in which wage-earners, widows and children—the most needy classes—will have safe depositories for their scanty savings.

A marvel in bridge-building is the lift-bridge, which supersedes the old-fashioned draw-bridge. It resembles an enormous elevator, and is raised to a height sufficient to allow the tallest ships to pass under it. The huge structure is raised by steam.

The latest wonder, the distance-

seer, reached us the last of the century from Poland. The inventor is Jan Szczepanik (pronounced Shtepanik), and he has discovered a way of seeing at a distance by transmitting vision over wires. It involves photography, electricity, and other departments, and we therefore place it under "Miscellaneous Inventions." Says Pearson's Magazine: "He finds himself to-day, after starving and struggling through many vicissitudes, lifted from the obscurity of a Galician school-house to a fine eminence, with scientists envying him, news-gatherers pursuing him, and capitalists tendering him millions—all at the age of twenty-seven. The 'distance-seer,' or 'telectroscope,' is beautifully simple in its underlying principle. It depends on this familiar fact: That any vision or image produced on the retina of the eye is only the blending together of an infinite number of points projected separately from the object, seen by separate rays of light. For instance, when we see a man or a house we really receive in the eye perhaps a million, perhaps ten million, distinct pictures of distinct points on the surface of that man or house. Szczepanik has found a way of separating any image that may be formed, by an ordinary photographic lens, into its component luminous points, of transmitting these points separately, but with enormous rapidity, over wires, and of letting the eye reconstitute them at the other end into the original picture."

HENRY GREATHEAD.

[Born 1757. Died 1813.]

E GREATHEAD LIFEBOAT AT SEA

o statue has been erected to Greathead's memory. Well, perhaps none is wanted. Of Sir Robert it was said that every policeman was a statue to his memory; and so with equal truth it may be hat every life-boat is a monument to the memory of Henry Greathead. Every one has reason to oud of that son of the Tyne whose invention it practically was, since it is blessed by the whole zed world, and has been the means of preventing untold sorrow and incalculable misery.

CHAPTER XXVI.

LIFE-SAVING APPARATUS.

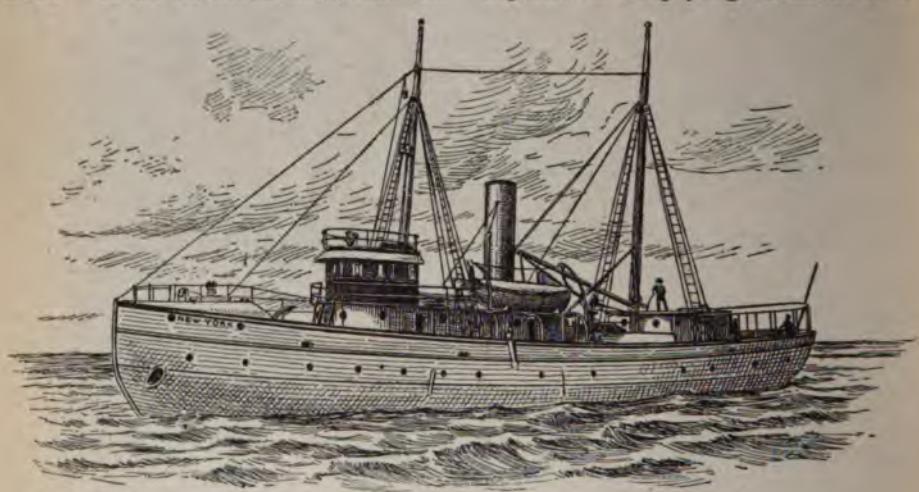
LIFE BUOY — LIFEBOATS — LIFE RAFTS — SIGNAL SERVICE — LIGHTHOUSES — WEATHER BUREAU—DRUMMON LIGHT.

THE invention of the lifeboat is claimed by several persons, Lionel Lukin (1742-1834), William Wouldhave (1751-1821) and Henry Greathead (1757-1813). Lukin took out letters-patent in 1785, but his craft does not seem to have been successful. Wouldhave improved upon Lukin's boat, and immediately after a great wreck in 1789, a premium was offered for the best design, for which Wouldhave and Greathead competed, and the prize was awarded to the latter. He received $6,000 from the government, a hundred guineas from the Trinity House, and a like sum from Lloyd's, a gold medal from the Society of Arts, and a diamond ring from the Emperor of Russia. "On the 23d

AN OLD-FASHIONED PILOT BOAT.

of November, 1803, there occurred an episode which showed that Greathead possessed a large amount of physical courage in addition to a high mental capacity; for on that day the 'Bee' of Shields put to sea, but encountering rough weather the captain determined to re-enter the Tyne. In taking the bar at the mouth the ship struck the ground, lost her rudder, became unmanageable, and finally drove on the rocks known by the name of 'Black Middins.' A crowd assembled, and the same tragedy which had been the primary cause of lifeboats ever having been instituted seemed likely to be re-enacted, for all declared that it was too rough for the boat to put out. Suddenly Greathead stepped forward and offered to go out himself to the rescue, if a crew would volunteer. His words had an electric effect on those present; hundreds stepped forward, and the difficulty now was whom to choose without offending the others. A selection, however, was finally made, chiefly consisting of pilots; the lifeboat was launched, reached the ship without any great difficulty, and rescued everybody on board without the loss of a single life."

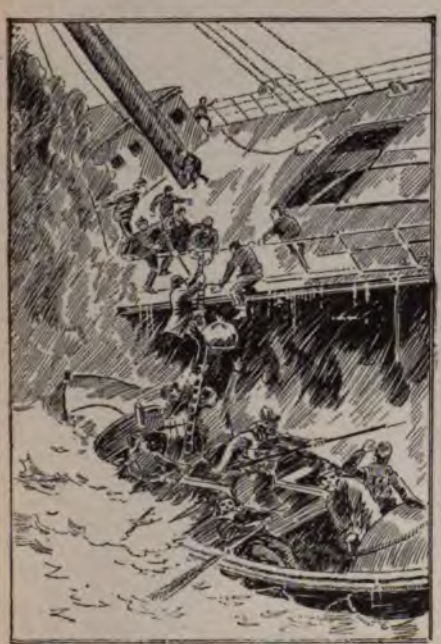
Great improvements were subsequently made, and in the Crystal Palace, in 1851, large numbers of boats were on exhibition with air-tight compartments, cork linings, some of wrought and sheet iron, gutta-percha tanks, air-tight, some capable of emptying themselves of water when filled, etc. A tubular double boat was invented in 1853 by H. F. Richardson, consisting of two tubes of tinned iron; Clarkson's, invented the same year, etc. Besides these are life preservers, life rafts of vulcanized rubber tubes, life cars, and all kinds of expedients for rescuing wrecked sailors and crews. Francis's metallic lifeboat (1839) ranks high.



A MODERN PILOT BOAT.

The life-saving service is another of the many succors devised for the

safety of seafarers. On all the coasts of all Christian countries trained men and apparatus are



THE LIFEBOAT AT WORK.

stationed, and the lives of those imperiled by storm are saved as never before the present century came.

Occasional fires of wood and coal were kept burning in a few dangerous places on the coasts of civilized countries as early as the seventeenth century, and the famous Eddystone lighthouse, near Plymouth, England, was built in 1759.

But the lighthouses on the Isle of Man were not illuminated with oil till 1816, and even the lights in the Eddystone were candles until the beginning of this century. But the Argand lamp, an oil lamp with a tubular wick, the coal-oil lamp, the gas light, the electric light, reflector mirrors and refracting lenses, the famous Fresnel (1823), A. J. Fresnel (1788-1827), the Drummond, and many ingenious appliances, are all the work of this century, and the mariner and the voyager have their security at sea increased a thousand-fold by the wise and humane inventions that light the sea on dangerous coasts.

The Drummond light is a light invented by Lieutenant Drummond, about 1826, to supply a deficiency which was found to exist in the means of making distant stations

A REVOLVING LIGHT.

visible from each other. It is made by exposing a small ball of quicklime to the action of the oxy-hydrogen blow-pipe, or the lime may be placed

in the flame of a spirit-lamp, fed by a jet of pure oxygen gas. Drummond's apparatus was so constructed that the lamp fed itself automatically with spirit and with oxygen, supplying itself with balls of lime as they were gradually consumed, and was provided with a parabolic silvered mirror. With this apparatus the light produced by a ball of lime not larger than a boy's marble was visible at a distance of nearly seventy miles, in a direct line. Subsequently, Colonel Colby made a lime-light signal visible a distance of ninety-five miles in a straight line. It is stated that, intensified by a parabolic reflector, it has been observed at a distance of 112 miles.

The Franklin life-buoy is the design of Philip Hichborn. The buoy is an annular tank of copper, divided into several water-tight compartments, and two upright swinging arms, weighted at the lower ends, are fixed to the sides. The lower ends of these arms—which are pipes—are filled with phosphide of calcium, a chemical which ignites by the action of the water. In response to the cry the quartermaster or man nearest the position of the buoy against the vessel's side trips the triggers and down it plunges. No matter which side turns uppermost, the weighted ends of the arms, with their burden of phosphide of calcium, swing under the water, and from the upper end of the tubes a bright flame burns at night to guide the drifting man, or a cloud of smoke does like service by day. The buoy will hold one man up in a sitting position and support two clinging to it, and a pendant life chain within the ring readily enables men to get up to it and rest.

The use of life-lines, buoys, rockets, etc., saves multitudes of lives, that would have been sacrificed in their absence. One of the best of the life-preservers is one in which Paul Boynton accomplished 600 miles. Every ship now carries life-preservers in its outfit, and life-saving stations are in all exposed situations on sea shore or lake shore, in all civilized countries,—solely the work of the Nineteenth Century. Life-boats mechanically propelled were devised in 1888, by steam and electricity in 1890, self-lighting in 1887, etc. George W. Manby (1765-1854), invented the method of shooting a rope from a mortar to a ship in danger.

Less than half a century ago, 1854, Professor Joseph Henry (1799-1878), of the Smithsonian, begun to gather and scatter meteorlogical reports. In 1857 the English Board of Trade began to publish data. Reports have been sent from Washington since 1870, the organization of the Weather bureau, daily.

The Weather bureau, by means of recording instruments, and intelligent observation, and by telegraphic communication through its agents in all parts of the country, advises every part of the country of the probabilities, so that storms are foretold, and ships, farmers and others are advised in time to make all needed preparations. Before the advent of the telegraph this was not possible, nor was it possible before this century came in.

DAVID LIVINGSTONE.

[Born 1815. Died May 1, 1873.]

Funeral anthems sometimes bear an exulting resemblance to songs of triumph; and never was the likeness more marked than when, on April 18, 1874, Westminster Abbey received the dust of Livingstone. The glory of the dead hero was pure. His escutcheon could be held up fearlessly in the face of the world; the most malignant scrutiny would fail to discover a blot on that stainless surface. He had fought no battles but those of religion and civilization, and had spilt no blood, and had dried tears in place of causing them.

CHAPTER XXVII.

GOLD—DIAMONDS, ETC.

NEW DISCOVERIES OF GOLD—CALIFORNIA—AUSTRALIA—ALASKA—J. W. MARSHALL—NEW METHOD OF GOLD MINING—DIAMOND FINDS.

MORE or less frequently and plentifully gold has been found in all parts of the world, and in all ages, but the vast amount mined during the century in California, Australia, the Rocky Mountain states, Alaska, etc., deserves to rank among the great discoveries of the century. Cronise in his "Natural Wealth of California," a standard work on the resources of the Golden State, informs his readers that the first gold known to have been found in the state was obtained in 1833, in the valley of Santa Clara, Los Angeles County. Hittell, in his new history, recently issued, places the discovery in 1842. William Heath Davis, in his "Sixty Years in California," gives the date of the discovery 1840, and the discoverers a party of Sonorians traveling to Monterey. In September, 1847, J. W. Marshall, proprietor of a sawmill on the Sacramento River in California, discovered gold grains among the sand in his mill-race. Historian Bancroft records that "James Wilson Marshall entered the service of John A. Sutter in July, 1845. Early in the afternoon of Monday, the 24th of January, 1848, while sauntering along the tail-race inspecting the work, Marshall noticed yellow particles mingled with the excavated earth, which had been washed by the late rains. He gave it little heed at first; but presently, seeing more, and some in scales, the thought came to him that it was gold. Sending an Indian to his cabin for a tin plate he washed some of the dirt, separating thereby as much of the dirt as a ten-cent piece would hold; then he went about his business, stopping awhile to ponder on the matter. During the evening

GOLD MINING IN THE TRANSVAAL.

he remarked once or twice, quietly, somewhat doubtingly, 'Boys, I believe I have found a gold mine.' 'I reckon not,' was the response; 'no such luck.' Up betimes next morning, according to his custom, he walked down by the race to see the effect of the night's sluicing. The headgate being closed at daybreak, as usual, other motives prompted his investigation, as may be supposed, and led to a closer examination of the debris. On reaching the end of the race a glitter from beneath the water caught his eye, and bending down, he picked from its lodgment against a projection of soft granite some six inches below the surface, a larger piece of yellower substance than he had seen. If gold, it was in value about one-half dollar. As he examined it his heart began to throb. Could it, indeed, be gold? Or was it only mica, or sulphuret of copper, or other ignis fatuus? Marshall was no metallurgist, yet he had practical sense enough to know that gold is heavy and malleable, so he turned it over and weighed it in his hand; then he bit it; then he hammered it between two stones. It must be gold! And the mighty secret of the Sierras stood revealed."

The people of San Francisco, Cal., and ultimately of all the civilized world, flocked to the mines until the yearly product of gold reached the enormous sum of $65,000,000. Later other sections of the country produced vast amounts of the precious metal, which is still mined in great quantities. From the best figures obtainable, it appears that California, since the first discovery in 1848, has produced more than $1,400,000,000 of gold. The amount of gold produced throughout the world in 1893 was $150,000,000. In April, 1851, a similar discovery was made in Victoria, and the Australian gold fields have since yielded enormous amounts of gold; $1,500,000,000 has been produced in all the gold fields in the world in a single year, but the value of the yellow metal has not been diminished.

Just as the increased demands of business were exhausting the supply of gold for the needs of the world, in consequence of the increased ability of labor-saving machinery, and it was realized that the mines of Russia and South America were unequal to the demand, it was found that California and Australia, and the Rocky Mountains could furnish the supply. The annual supply rose from ten to thirty-five million, and in thirty years the world's supply increased one thousand million. Similarly, it was seen that enormous amounts of coal must be had, and lo, in all parts of the world the supply was discovered packed away æons before in anticipation of human needs. The greatest of all the discoveries of gold was in California, which has long been known the world over as "the bright land of gold." The discovery led to the memorable "gold fever" of 1849. In 1849, California gold dust was worth $12 per oz., in cash, and between $15 and $17 in trade at the stores. The tariff on ordinary commodities reached a phenomenal and curious height. A suit of clothes cost $225; a shirt, $30; a

pair of shoes, $50; a hat, $25; a pair of trousers, $45; coat and vest, $75; a comb, $5; a toothbrush, $5; a can of peaches, $15; a can of oysters, $8; a barrel of pork, $225.

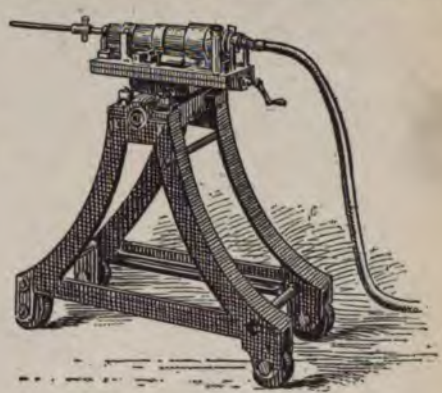
The latest furor relates to Alaska, and "Klondike," in 1898-99, is as

SCENE IN A DIAMOND MINE.

much a word to conjure with as was "California" a half century before.

New methods of gold mining and new machinery are peculiar to this century. Quartz mining consists in crushing gold-bearing quartz, and segregating the almost invisible particles of gold. Winnowing machines and revolving fans are used in placer mining. Instead of sifting a few pans of dirt as formerly, two men can work five tons of earth a day by this method. Hydraulic mining by pan, rocker, sluice box, and water from a height forced through a pipe, that washes away earth and stones and leaves the heavier gold, drift mining by shafts and tunnels, and river mining, which turns a river from its bed, and is made to run parallel with its natural course, etc., are all modern methods. The finer particles are arrested by quicksilver mingled with the "pay dirt," which amalgamates with the gold, silver, copper, lead, iron and other metals are procured and refined by new processes peculiar to this century, unthought of before. Silver is mined and refined by three methods, amalgamation, lixivation and smelting by processes peculiar to the present age.

The great discovery of diamonds in South Africa is memorable. In 1867 some children found a pretty pebble on the banks of the Orange River. It went from hand to hand till the governor of the colony bought it for $2,500. Soon others were found, and a general search was begun. One gem was found valued at $125,000. Then ensued a rush of thousands from all parts of the world, and millions of dollars have been realized from the diamonds found in this locality. Before this Brazil was the greatest diamond-producing locality, discovered in the eighteenth century, and Golconda in



DRILL USED TO DISLODGE QUARTZ.

Hindostan was the only other large diamond deposit.

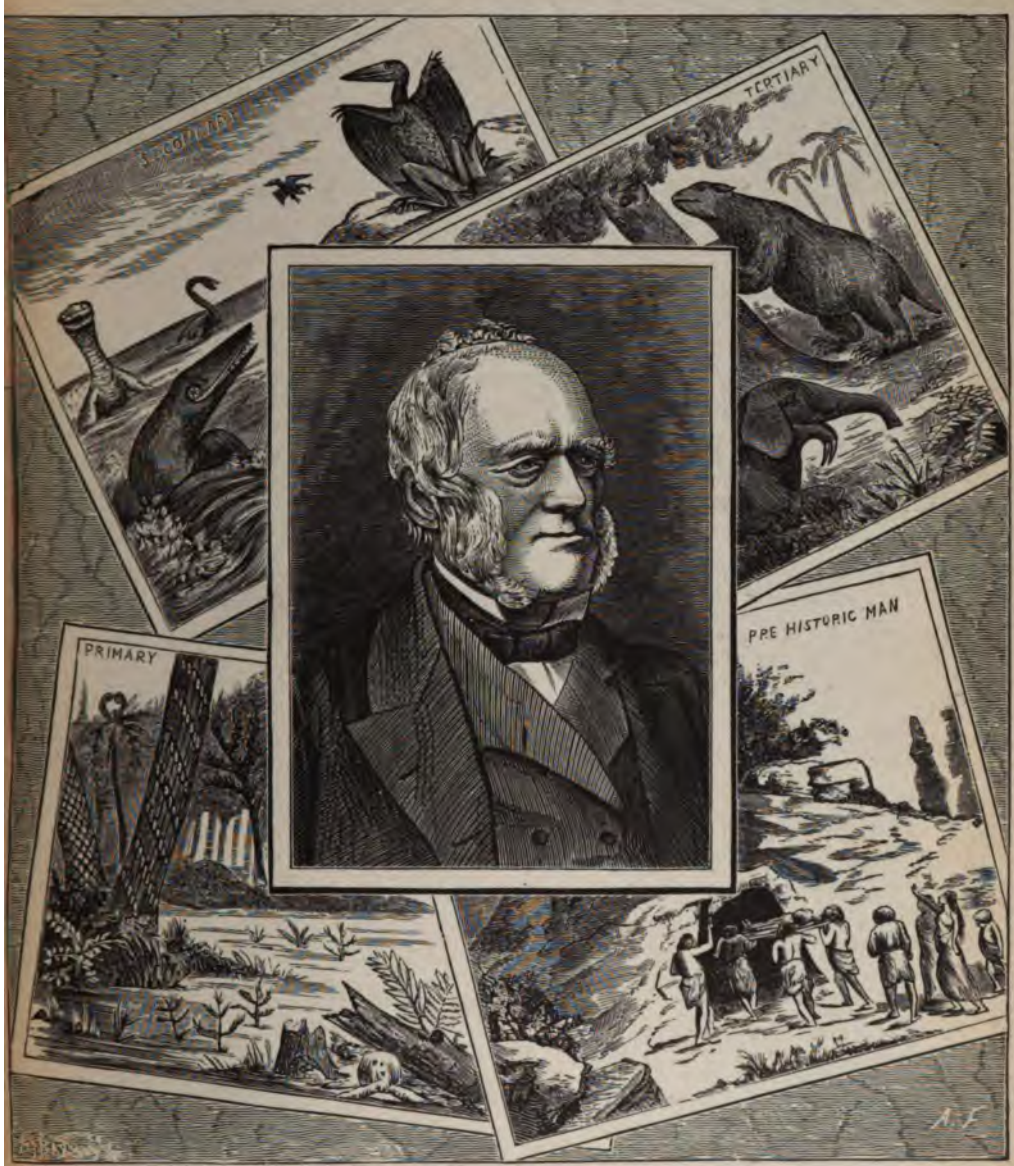
Among the great diamonds of the century is the Kohinoor, or Mountain of Light, which has a

legendary history, and which is said to have belonged in turn to Shah Jehan, Aurungzebe, Nadir Shah, the Afghan rulers, and afterward to the East Indian Sikh chief, Runjeet Singh. Upon the abdication of Dhuleep Singh, the last ruler of the Punjab, and the annexation of his dominions to the British empire, in 1849, the Kohinoor was surrendered to the Queen of England. It was accordingly taken to England and presented to her, July 3, 1850.

Its original weight was nearly 800 carats, but it was reduced by the unskillfulness of the artist, Hortensio Borghese, a Venetian, to 279 carats. Its shape and size resembled the pointed half (rose cut) of a small hen's egg. The value is scarcely computable. This diamond was re-cut in 1852, and now weighs 102¼ carats.

SIR CHARLES LYELL.

[Born 1797. Died 1875.]



How profound and fruitful his studies and speculations must have been during this period, when he gave to the world his "Principles of Geology." This book marks an epoch in the progress of the science. Lyell's aim was to establish principles, to lay a solid and philosophical basis for the science; and this by showing that a true and sufficient explanation of the phenomena of the past is furnished by the belief in the uniform action of forces now in operation.

CHAPTER XXVIII.

GEOLOGY.

THE SCIENCE A CHILD OF THE NINETEENTH CENTURY — LYELL — MILLER— BUCKLAND—HITCHCOCK—THE GLACIAL THEORY.

THE science of geology has been developed within a hundred years. The wisest men of a hundred years ago supposed that the remains of shells on the Alps were left there by travelers as they crossed the mountains. And though there were glimpses of geological truths among the ancients, scientific knowledge is very modern. The best geologist of antiquity was the geographer Strabo (B. C. 60-24).

Modern geology began with Abraham Gottlob Werner (1750-1817), who was a professor in the School of Mines, at Freiberg, in Saxony, in 1775. Werner believed that a series of universal formations had been deposited in succession from a chaotic fluid. Basalt was supposed to have had the same origin, but to this view various continental observers were opposed. Hutton published, in 1788, his "Theory of the Earth," developed in a separate work in 1795. He assumed no causes but those now existing. He showed that geology and cosmogony were different. "In the economy of the world," he said, "he could find no trace of a beginning, no prospect of an end." He held basalt, granite, etc., to be of igneous origin. He was author of the Neptunian hypothesis. In 1798 Cuvier published his *Ossemens Fossiles*, which gave a great impulse to palæontology. His theory was accepted as lately as 1830. After inquirers had outgrown the belief in fossils produced by the plastic power of nature, or all entombed simultaneously by the Noachian deluge, the belief was entertained that there had been a series of creations and catastrophes, the latter causing the universal destruction of all pre-existing species. The belief was also entertained that some external causes, say the forces producing earthquake and volcanic action, were more potent in former times than now. This Professor Huxley calls Catastrophism, which he defines to be any form of geological speculation, which, in order to account for the phenomena, supposes the operation of forces different in power from those which are at present in action in the universe. Sir Roderick Murchison was of this school, and Playfair, and many continental geologists.

The second school of geology is that called by Huxley Uniformitarianism. This looks only to causes now in operation for the explanation of geological phenomena. This school Sir Charles Lyell (1797-1875) carried forward to triumph. He showed the enormous changes which the causes now in operation are still

producing, and that nearly every phenomenon, attributed to abnormally potent causes acting suddenly and briefly, could be produced by causes not more intense than those in action now, but operating through immense periods of by gone time. In his "Principles of Geology" he examines aqueous causes, the action of water acting in connection with tides, currents, etc., in seas, rivers, and lakes; also the action of ice in all its forms. Next he inquires into igneous causes, volcanoes and earthquakes. Climate and organic life are also carefully investigated in the work.

The doctrine of the third school of geologists is called by Professor Huxley, Evolutionism; it accepts nearly the whole of Uniformitarianism, except the part referring to the development of organic life.

The facts of a recent glacial period over most of the earth's surface, and that man had dwelt in the northern hemisphere with extinct animals, so that the human race is of great antiquity, were established during the century. These facts are among the triumphs of geological science during the latter part of the century. Venetz, in 1822, and after him Charpentier and Agassiz, so generalized from admitted data that all geologists now adopt their conclusions that an ice-sheet through which only the highest mountains pierced covered the northern hemisphere, all the way from 20,000 to 40,000 years ago, and that the ice age lasted at least a thousand centuries.

Charles Lyell obtained his first leanings toward geology from William Buckland (1784-1856). His great work, "Principles of Geology," appeared in 1830-33. It was an epochal work in the new science. It established the doctrine that the geological changes in the earth have resulted from causes now operating.

Hugh Miller, in the "Old Red Sandstone" and "The Testimony of the Rocks," and other works, has embodied the evidences of a rare genius.

Among the eminent geologists of the century may be named: William Buckland (1784-1856), W. B. Dawkins (1838), Geo. M. Dawson (1849), J. W. Dawson (1820), A. Geikie (1835), James Geikie (1839), C. H. Hitchcock (1836), Edward Hitchcock (1793-1864), James Hall (1811), T. S. Hunt (1826), John W. Judd (1840), C. T. Jackson (1805-1880), G. A. Mantell (1790-1852), J. MacCulloch (1773-1835), R. D. Murchison (1792-1871), Hugh Miller (1802-1856), the "stone-mason of Cromarty," A. C. Ramsay (1814-1891), Adam Sedgwick (1785-1873), A. Winchell (1824-1891), J. D. Whitney (1819), John Playfair (1748-1819).

Up to 1830 Cuvier was authority in geology, but at that time Charles Lyell gave out his "Principles of Geology," and established the uniformitarian theory, that is, that the earth's changes are due to causes now operating, and not to sudden convulsions. This theory is now considered by scientists as established. This history of past ages has been revealed, as it is written on the rocky strata, including the antiquity of man, during the century.

THE U. S. GOVERNMENT BUILDING.

"One of the most notable structures at the Paris Exposition of 1900."

THE WORLD'S COLUMBIAN EXPOSITION.

"It still lives in the imagination of the thousands who saw its wondrous sights."

The glacial theory is another step of progress. The existence of a former ice age was first stated by Venetz, in 1822. Subsequently Charpentier, Agassiz and others fully established the fact, and showed that the remaining glaciers are the rear guard of forces that once were operative over a large part of the northern hemisphere.

Ossian Guthrie (1826) has recently established the fact that nearly all the bowlders scattered across the country have been pushed by glacial streams, and were not carried by icebergs, as has generally been supposed. His investigations have revolutionized glacial geology. He has identified bowlders that have traveled, pushed by glaciers, from Lake Huron and Georgian bay and British America, where their parent ledges are, for hundreds of miles, and has even found them in the grooves where they were left when the glacier had done with them. The region of Chicago, "he has discovered, was the main pathway of one of the most stupendous glaciers which the Creator has ever set in motion. This glacier, which originated in Hudson's bay and extended south below the thirty-eighth parallel of latitude in Illinois, had gathered and incorporated within itself rocks and debris from an area of possibly a hundred thousand square miles. Upheavals of igneous rocks had paid so bountiful a tribute to its demands as to become a conspicuous feature of the glacier itself, long before it had reached this latitude. These rocks were set like diamond cutters in a glacial matrix of such depth as to give, possibly, a pressure of 2,000 pounds per square inch upon the bed rock." (See "Canals.") Mr. Guthrie has solved the problem of accounting for bowlders on mountain tops, by glacial action. The top of the glacier moves faster than the bottom, producing a vertical rotation, and the center faster than the sides, producing a double horizontal rotation, thus carrying debris from side to center and from bottom to top. He has exploded the popular idea of a terminal moraine, and demonstrated its impossibility.

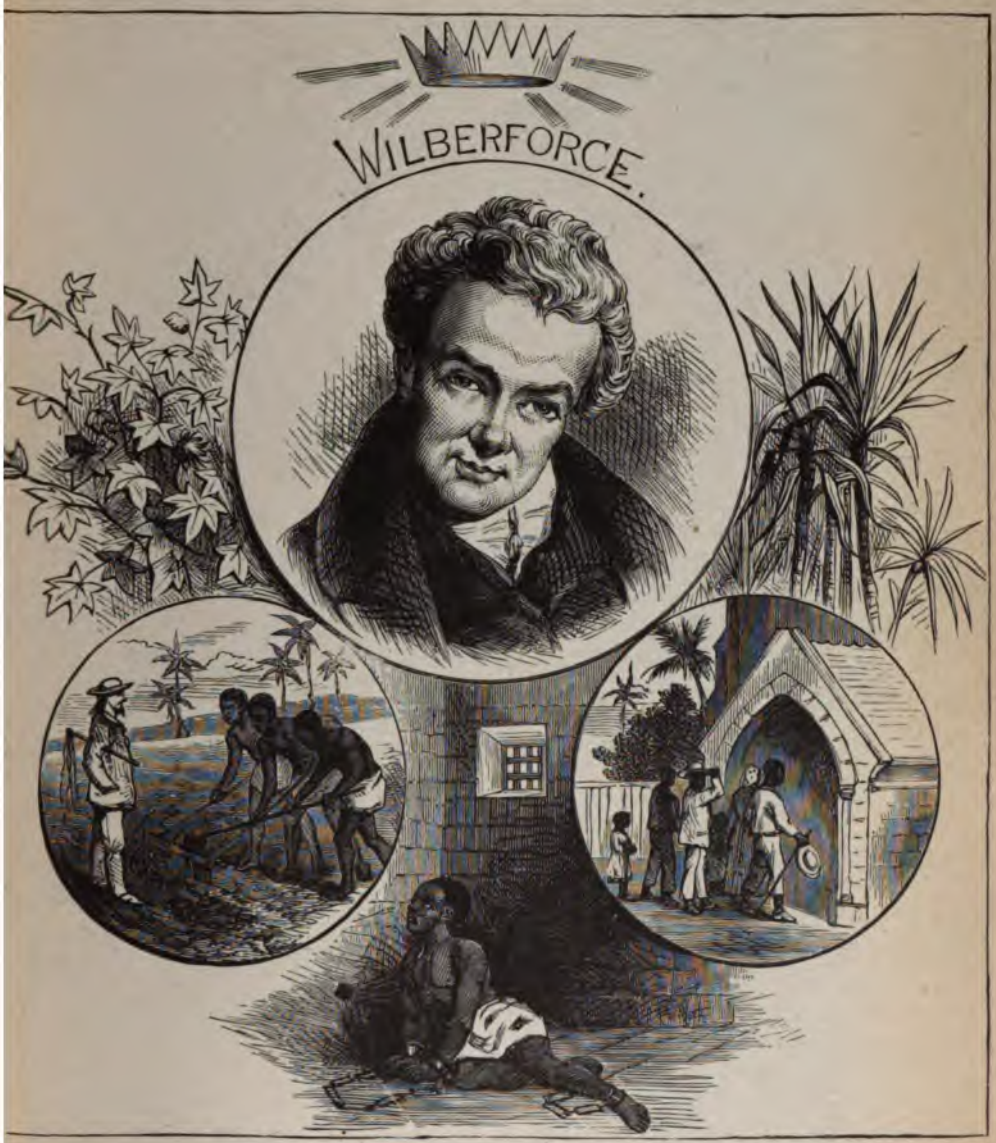
It was not until the present century was well advanced that the rocky pages of the book of nature were intelligently scanned, and the character of the strata on which the finger of God had inscribed the story of the procession of events was read aright. Now the observer can unroll the scroll, and trace the building of the earth from the time when its granitic foundations were laid on the igneous masses, up through the many sedimentary strata, to the alluvial deposits, and can read the story of progress from mollusk up to man. Less than a century ago all was obscure, an unreadable enigma; now, through the researches of reverent and indefatigable students the records are clear; and it has been demonstrated that man, once supposed to have been an inhabitant of this planet but sixty centuries, has dwelt on the earth a length of time that extends indefinitely into the remote past,—more millenniums of years than ancient belief supposed to have been centuries.

The geologist is now able to trace

as clearly as though the story were found recorded in words, the time when the earth was an incandescent mass; when the coal measures were deposited; when the terrible glaciers plowed their furrows in the rock, and ground the solid granite into soil; when in fact all the processes of world-building were going on, resulting in the present order of nature. All this was unknown a hundred years ago, and until Geology, the child of the Nineteenth Century, came, and told the wonderful story.

WILLIAM WILBERFORCE.

[Born Aug. 24, 1759. Died July 29, 1833.]



He desired above all things for his country that her sword should strike only on the side of Right, that her crown should be the crown of Righteousness, and her place in the van of Truth. He could not endure to see her do wrong; a stain on the national honor chafed him as though it soiled his own. And beholding, even while yet a boy, how miserably the leprosy of slavery had spotted that beloved motherland, he resolved, God aiding, that his life should be devoted to freeing her of her shame.

CHAPTER XXIX.

EXPOSITIONS.

THE GREAT INTERNATIONAL EXPOSITIONS—ENGLAND—VIENNA—PARIS—PHILADELPHIA—CHICAGO—PARLIAMENT OF RELIGIONS—PRINCE ALBERT.

IN recent years the great nations, or their constituent communities, have from time to time held expositions showing the progress made by themselves, and in many instances that made by their co-operating neighbors, who accepted invitations to participate in such exhibitions. The most prominent of the earlier expositions in this country was that held in Crystal Palace, New York City, which, after a successful career of several years, was burned. In 1876 a more ambitious effort was made at the Philadelphia Centennial. Among European nations the spirit of enterprise was particularly active, and several notable expositions have been held in England (in 1851), Vienna, Paris, and other cities, especially remembered among these being the Parisian Exposition of 1889. But it remained for American enterprise, and particularly for the most enterprising of all the cities of this country, to inaugurate a movement that resulted in the gathering together and offering for the inspection of all the earth the Exposition *par excellence*, before the glories of which the achievements of all others pale into insignificance. The World's Columbian Exposition was designed to commemorate the discovery of the Western Hemisphere, and as that event had contributed to affect the fortunes of all the earth, the entire human race was invited to participate, and the invitation was almost unanimously accepted.

The idea began to interest the public seriously in 1888, although there had been talk of such an enterprise for ten years previous to that time. In the competition before Congress several cities urged their claims to be designated as its location. Chicago was successful, and the sum of $10,000,000 was pledged by the city and by private subscriptions for the purpose of constructing the buildings and preparing the grounds. The magnificent site finally selected for the exposition comprised Jackson Park on the shore of Lake Michigan, seven miles south of the business center of the city. The park embraces 586 acres, and is connected with Washington Park by Midway Plaisance, a parkway containing eighty acres. The site was an ideal one. Before construction of buildings began, landscape architects and gardeners made their plans for beautifying the grounds. Water and sewage systems were constructed, and every facility for electric lighting and for protection against fire was perfected. The

total cost of the great exposition structures, including the numerous state and foreign buildings, was more than $10,000,000. Every department of the exposition had for its chief a specialist in the work which was to be illustrated by that department. The buildings themselves were so constructed as to be the best adapted for exposition purposes of any that have ever been so used. In spite of their enormous size, applications for space for exhibitors were so numerous that it was necessary to sift out all but the best of the applications, and the result was a magnificent display of nothing but the best work of man and nature.

The exposition was publicly dedicated October 21, 1892, and the great pageant began on the first day of May, 1893, and closed October 31 of the same year. The expenses of the entire enterprise footed up to more than twenty-six millions of dollars, and the number of people who attended during the six months of its continuance was more than twenty-seven and a half millions. On one occasion (Chicago Day) there were within the grounds over 700,000 persons—the largest number ever in attendance anywhere for a similar purpose. It is doubtful if anywhere on earth a more fitting site could have been found. The fame of the "White City," as the exposition buildings were collectively called, went abroad over all the earth, and the World's Columbian Exposition forms an epoch, from which all the participating nations can reckon time. George R. Davis, born in Palmer, Massachusetts, January 3, 1840, was director-general of the World's Columbian Exposition, after having been an officer in the Federal army, member of Congress, etc. Thomas Witherell Palmer, born in Detroit, January 25, 1830, after large political successes, became president of the National Commission, and won the applause of hundreds of thousands of those who enjoyed that great enterprise. H. N. Higinbotham, of the house of Marshall Field & Co., became president of the Exposition succeeding Lyman J. Gage. C. C. Bonney originated one of the most interesting of all the features of this great affair, the World's Parliament of Religions. During the progress of the exposition various congresses were held to consider an almost infinite number of subjects, and to demonstrate the progress of man in all points, other than those set forth by the wonderful material evidences to be seen in the great buildings of the several departments. John Henry Barrows, D. D., a distinguished clergyman, presided over the deliberations of the parliament.

The Parliament of Religions was an epochal event. In all its features it would have been impossible at any period of time before the closing years of the Nineteenth Century. It was inaugurated in the art palace on Monday, September 11, 1893, and continued eighteen days. All nations, tribes and tongues seemed assembled in the Hall of Columbus. The Orient and the Occident clasped hands. From "India's coral strand," from Japan and China, clad in robes

of white, and red, and orange, the Oriental priests mingled with the sober-clad representatives of the West, and the group on the platform gave to the four thousand spectators a scene in the Auditorium such as was never before seen on earth.

Men and women of all the religious faiths of the world came together in a magnificent symposium, —a spectacle which must have delighted the angels of God, as it did the hearts of all who seek the unity of the spirit. For eighteen days, all day, and frequently in several rooms at the same hour, congresses of different Christian and non-Christian sects assembled, and discussed the great problems of the soul, and repeatedly in the great halls of the Art Institute, were held parliaments in which advocates of the world's religions were heard by vast audiences. The Being of God, the immortality of the soul, the inspiration of the Scriptures, Christianity, Buddhism, Confucianism, Mohammedanism, Hinduism, Judaism, Parseeism, Taoism, Shintoism, Zoroastrianism, Catholicism, Protestantism, in all its branches; all had their "inning," and all were given a respectful hearing.

Grouped on the platform were: Bishop D. A. Payne, Rajah Ram, of the Punjab; Carl Von Bergen, president of the Swedish Society for Psychical Research, Stockholm, Sweden; Birchand Raghavji Gandhli, B. A., honorary secretary of the Jain Association of India, Bombay; Rev. P. C. Mozoomdar, India; H. Dharmapala, India; Miss Jeanne Serabji, Bombay; Archbishop Ryan, Philadelphia; Rev. Alexander McKenzie, Massachusetts; Count A. Bernstorff, Berlin; Prince Serge Wolkonsky, Russia; Most Rev. Dionysius Latas, Archbishop of Zante, Greece; Homer Perati, Archdeacon of the Greek Church; Pung Quang Yu, of China; Bishop B. W. Arnett; H. Toki, Japan; Rev. Takayoshi Matasugma, Japan; Right Rev. Reuchi Shibata, Japan; Rev. Zitsuzen Ashitsu, Japan; Kinza Riuge Hirai, Japan; Swami Vivekananda, Bombay; Professor Chakravarti, Bombay; B. B. Nagarkar, Bombay, representative of the religion of the Brahmo Somaj; Jinda Ram, India; Rev. P. G. Phiambolic Occonomus, a priest of the Greek Church; Banriu Yatsubuchi, president of Hoju, Buddhist Society, Japan; Shaku Soyen, Arch Bishop of the Ten, of the Buddhist sects; Bishop Sanuki, Japan; Noguchi and Nomura, interpreters, Tokio, Japan; G. Bonet-Maury, Paris; Prince Momulu Massaquoi, of Liberia; Bishop Jenner, Angelican Free Church; Rev. Alfred Williams Momerie, D. D., London, England; Rev. Maurice Phillips, of Madras; Professor N. Valentine, William T. Harris, Dr. Ernest Taber, Rev. George T. Candlin, Professor Kosaki, Bishop Cotter, of Winona; Dr. Adolph Brodbeck, Z. Zimigrowski, Principal Grant, of Canada; Cardinal Gibbons, and these and others, representatives of every phase of religion were heard. The effect was ennobling, and contributed to that hoped-for era of good feeling and unity of the spirit which all genuine advocates of any form of religion should

strive to hasten. The great days of the parliament gave frequent foretastes of those millennial days for which the world waits. It was one of the great achievements of the Nineteenth Century.

The World's great expositions—all which are peculiar to the present century, have been held as follows: London, 1851; Dublin, 1853; New York, 1853; Paris, 1855; London, 1862; Paris, 1867; Vienna, 1873; Philadelphia, 1876; Paris, 1878; Sydney, 1879; Melbourne, 1880; Paris, 1889; Chicago, 1893; Paris, 1900. To Prince Albert (1819-1861), belongs the chief glory and credit of the first great exposition, and of the other exhibitions that have succeeded it.

FRIDTJOF NANSEN.

[Born at Great Froen, Norway, 1861.]

e intrepid and intellectual Arctic explorer bears a name to be proud of. Both on the father's side e mother's side he comes of a good stock. His maternal ancestry, he is proud to tell, can be back to the time of Charlemagne. At all events, it can be traced far enough back to a good Ger- ock. His paternal ancestor, Hans Nansen, was a daring rover of the seventeenth century who ied the Arctic seas and wrote a "Cosmography," containing sailing directions, which kept its own even to the present century.

CHAPTER XXX.

DISCOVERERS AND EXPLORERS.

SIR JOHN FRANKLIN—A. W. GREELY—HAYES—LIVINGSTONE—LAYARD—DU CHAILLU—NANSEN—KENNICOTT—HUMBOLDT—ANCIENT CITIES EXHUMED.

THE Age of Explorers was undoubtedly that extending from 1530 to 1630, but the present century has been glorified by the lives of gallant heroes who have gone forth in the interests of science to discover and explore lands unknown to civilization. Following the example of Christopher Columbus (1435-1506), Ferdinand Magellan (1480-1521), Sir Walter Raleigh (1552-1618), Sir Martin Frobisher (—1594), Capt. James Cook (1728-1779), and other great navigators and adventurers, was Sir John Franklin (1786-1847), who twice by land and twice by sea endeavored, among the rigors and horrors of arctic ice, to discover the long-sought-for northwest passage. His second voyage was by land, and was one of terrible hardships. After feeding on singed hides and lichens gathered from the rocks, the adventurers were reduced at length to collect bones that the wolves had picked clean, and make the wretched refuse into soup. A morsel of flesh, however putrid, was esteemed a luxury; and when, by rare good fortune, a bird had been shot, the starving wanderers were but too happy to eat it raw. Leaving several of the party in the wilderness, slain by starvation and frost, the feeble skeletons that were left succeeded finally in reaching an encampment of friendly Indians, and for the first time in months were supplied with something deserving the name of food. Even their shoes and the covers of their guns had been devoured in their extremity. In May, 1845, he sailed from Sheerness on his last and fatal voyage. The expedition consisted of two ships, the "Erebus" and "Terror." Men and officers were in high spirits, regarding the success of the voyage as all but certain, and their commander as the man of all men likeliest to achieve it.

The vessels passed northward, were met by a whaler at the entrance to the arctic seas, and then disappeared forever. Relief expeditions were sent out, and evidences were found that the ships had been abandoned, that many of the party were dead, and that the survivors, reduced to the last horrible expedient by which hunger seeks to prolong life, had wandered on through the arctic desert, perishing one by one.

Following their examples and those of other ancient explorers, the century has known the most courageous and brilliant struggles on the part of brave men to discover unknown countries. Among them

were Andree, S. W. Baker (1821—), G. W. DeLong, explorer of the Siberian Arctic (1844-1881), E. J. Eyre (1815—), A. W. Greely (1844—), Charles F. Hall, seeker of

HENRY M. STANLEY.

the north pole (1821-1871), James B. Lockwood (1852-1884), I. I. Hayes, searcher for the open sea (1832-1881), E. K. Kane (1820-1857), A. C. Laing (1794-1826), Fridtjof Nansen (1861—), M. C. Peary, who opened Japan to the world; R. E. Peary (1854—), J. C. Ross (1800-1862), John Rae (1813—), W. Scoresby (1790 - 1857), John L. Stephens (1805-1852), J. H. Speke (1827-1864), Charles Wilkes (1798-1877), discoverer of the antarctic continent; F. P. von Wrangell (1796-1870), etc.

Besides the inhospitable regions of cold and the pathless wilderness, the no less inhospitable realms of desert heat have had their heroic explorers. David Livingstone (1815-1873), for the sake of shedding the light of Christianity on "Darkest Africa," by extraordinary self-sacrifice, entire devotedness, and a perseverance that endured unto the end, gave his life to the cause he loved, and recorded his name high on the rolls of fame. He reconstructed the map of Africa, and in spite of the opposition of slave dealers, accomplished his great purpose of aiding "Ethiopia to stretch her hands to God." H. M. Stanley (1840), "Stanley Africanus," whose intrepid and valiant efforts found Livingstone, deserves a high position among the explorers and discoverers of the century. A. H. Layard (1817), Paul Belloni Du Chaillu (1835), discoverer of the Dwarfs and Giants (1835), etc.

Not less courageous than these are the heroic spirits among the trans-continental adventurers who followed the example of Louis Joliet, the discoverer of the Mississippi (1645-1700), and Peter Le Moyne, the founder of Louisiana (1661-1706). Such were Robert Gray, the discoverer of the Columbia

FRIDTJOF NANSEN.

river (1757-1806), Daniel Boone (1735-1829), Meriwether Lewis (1774-1809), and William Clark (1770-1838), the first trans-continental explorer of the United States; Zebulon

mery Pike (1779-1813), ex-
f the sources of the Missis-
ohn Charles Frémont, the
der (1813-1890), and the great
pioneers who have followed
s they blazed, and who have
he wilderness blossom with
ion.

l Boone (1735-1820) was the
plorer and pioneer. He en-
Kentucky almost alone, and
d that beautiful region, sur-
l by wild beasts and wilder
He broke the path through
lerness, and opened the way
lers in the great northwest.
age, hardihood, enterprise,
the ideal pioneer.

rd Taylor (1825-1879), poet,
ur and prince of observers
velers, brought foreign lands
the knowledge of thousands
hted readers.

Wesley Powell (1834) devoted
ier years to geology; entered
y and lost an arm; was pro-
f geology in college, but per-
his greatest feat in exploring
nd Canyon of the Colorado.
at is without parallel in ad-
in the century. He was
the Bureau of Ethnology till
d director of the Geological
till 1894.

hus Washington Greely
after serving through the
ar, in 1881, was placed in
d of an expedition to the
regions. He sailed in the
s," July 7, 1881, and after
hardships reached a point
egrees north and 64.45 de-
vest. He made important
ries of lakes and mountains
in Grinnell's Land and added much in other ways to our knowledge of the Arctic circle, but found himself without means of returning, the relief expedition promised having failed. Awful sufferings ensued. Sixteen of the party died of starvation, one was drowned and one was shot. The third expedition sent to his aid succeeded, and those left of the party were rescued when, two days later, they must all have been dead. In 1887 President Cleveland appointed the intrepid explorer, the man who had so endured, to the command of the Signal service, with the rank of brigadier-general.

Fridtjof Nansen (1861). While yet a youth, the great explorer went to the Greenland seas with a sealer, and on the voyage resolved to cross Greenland and reach the North pole. In June, 1893, he sailed from Norway, and was frozen in near the New Siberian islands. He had reached eighty-four degrees of latitude, and on March 14, 1895, with his kayaks (skin or canvas canoes), his sledges, and his available dogs, Nansen and a companion committed themselves to the tender mercies of the restless ice. In three weeks, in a northerly direction, these two fearless men reached eighty-six degrees fourteen minutes north, some 150 miles from the ship. But Nansen was not satisfied. Alone on his ski, he hurried another dozen miles towards the Pole, but nothing but a waste of ever-moving ice was to be seen. And so the two, with scarcely a dog left, made haste to reach some haven, and fortunately, in a marvelously short time, they

struck Franz Josef Land, on the coast of which they wintered, and in the summer of 1896 they were rescued.

This unprecedented expedition revealed to us that the North Polar area is in all probability landless. It sounded hitherto unvisited seas, and proved that previous conjecture was wrong, and that, instead of being shallow, the Arctic ocean is 1,500 fathoms deep.

Ten Arctic and Andree relief expeditions are now (1898) in the seas of the North Pole. Three other bands of fearless men are beating the ice of the Antarctic in search of the South Pole. A few of the perilous trips have been undertaken as private enterprises; the others are backed by European governments in the name of science.

America has Wellman and Peary in the Arctic field; Norway has Sverdrup and Borchgrevink far below Cape Horn; Sweden has sent out Nathorst, Nordenskjold and Stadling; Denmark hopes for glory in the findings of Amdruf; Russia has dispatched Admiral Makarof to solve the north riddle; the French are waiting for word from La Chambre's party; the Italians think Prince Luigi will come back with the pole itself; while the Germans are positive that Von Drygalski will gather the secrets of the farthest south; and the Belgians have as great faith that De Gerlach will be as successful in the same seas.

Robert Kennicott, the first Alaskan "boomer," was born in New Orleans in 1835, and moved to Chicago early in the forties. The Audubon Club of Chicago and the Smithsonian Institution combined to form an exploring expedition to the great and unexplored northwest in search of the unknown flora and fauna of that territory. This was in 1859. Young Kennicott, not only because of his erudition in such matters, nor because of his physical qualifications—he was less than five feet seven inches tall and weighed only 120 pounds—was chosen to head the expedition. The party started from Chicago in the spring of the year, and followed the Hudson Bay Fur Company's route, and arrived at Pembina. There Kennicott realized the possibility of getting farther north. He returned to Chicago and was commissioned to go on a second expedition. In August, 1860, Kennicott left Fort Resolution and descended the Mackenzie river to Peele river, in latitude 67:30, and then proceeded westward, crossing the mountains to La Pierre's house. He arrived there on September 18, and on the following day he descended the Porcupine river to Fort Yukon, which he reached September 28. There he spent the winter of 1860 and 1861 hunting, trapping and securing specimens for the Smithsonian Institution. It was while there that Kennicott wrote about the valuable mineral deposits of the territory. But these had no charms for him further than from a scientific point of view. Kennicott spent two years in Alaska, roaming hither and thither on his mission, and arrived home October 17, 1862. In 1866 the Western Union Telegraph Company decided to build a line

across Behring Strait, in order to connect America with Europe. Kennicott was known to be the only white man who had ever been through the Alaskan country, and his services were secured to locate the line. He proceeded with a party of scientists to California and up to the mouth of the Yukon. With a single companion he ascended the Yukon that winter a distance of 600 miles, where death came upon him suddenly from heart disease, in the year 1866.

Greatest of travelers and explorers was Frederick Henry Alexander von Humboldt (1769-1859), whose learning and scientific trophies easily place him first among those who have added to mankind's treasures of knowledge and exploration. Rich, eloquent, scientific, indefatigable, he allowed no obstacle to interpose between himself and the purpose of adding to the stores of human knowledge. One journey of five years, accompanied by Aimee Bonpland (1773-1858), beginning in 1799, was undoubtedly the most famous journey of exploration ever recorded, certainly the richest in reliable information. Six thousand different species of plants were among the spoils of the expedition. But the great value of the five years' journey was the vast body of scientific investigations, the innumerable physical facts, the voluminous records of observations, made by the cultivated and enthusiastic travelers. Under the influence of Humboldt's poetic genius the dry records of scientific phenomena became transformed into brilliant pictures. His descriptions glow with the fervor of a genuine artistic imagination. The account of the journey caused the Edinburgh "Review" to say of Humboldt: "A traveller armed at all points, and completely accomplished for the purpose of physical, moral and political information, . . . an astronomer, physiologist, botanist, one versed in statistics and political economics, a metaphysician, antiquary, and a learned philologist, possessing at the same time the enlarged views, the spirit, and the tone of true philosophy." And yet, so conscious was he of his failure to accomplish what he had hoped to do, that in one of his last letters he wrote: "I live joyless because of all I have striven for from my youth I have accomplished so little."

ANCIENT CITIES.—A volume of thrilling interest could be filled with descriptions of the remains discovered in the southwest, of ancient peoples who once inhabited those great sections. They were at least semi-civilized, and far excelled the Indian tribes that drove them out of their homes, mostly cliff dwellings. The Zunis are probably their descendants. Vast areas, now arid and barren, were then irrigated and cultivated, and their domestic utensils and ornaments indicate a good degree of culture. A recent government explorer, Professor Fewkes, describes the result of exploring a ruined city near Snowflake, Arizona:

"We made extensive excavations here, and unearthed a large collection of objects of pottery, stone and shell. Some of the pottery is the most beautiful ever brought from

the southwest. Among other things we found a curious copper bell, which shows that the ancient inhabitants were familiar with metal-working—bracelets made from the shells of the Pacific, 500 miles away; well preserved gourd rattles, on which the colors were still brilliant, and needles and awls made of deer' bone.

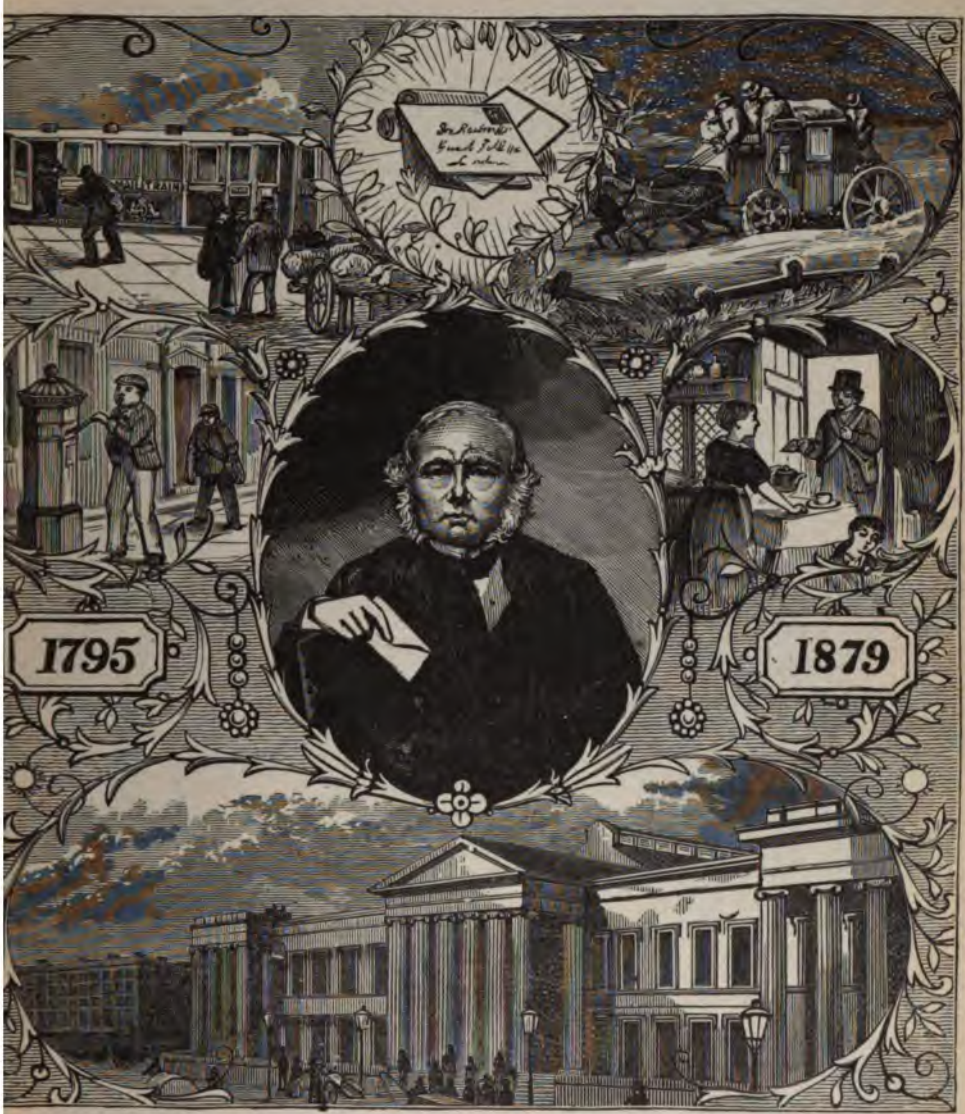
"One of the most beautiful specimens of pottery was a globular bowl, of red color, highly decorated and having a graceful spout and handle. It was probably used as a water vessel. We found the remains of the children buried in the fire places, according to the ancient Moqui belief that the immature must be so disposed of in order to make the journey to the under world. The adults, however, were found just outside the walls of the town. One of the rooms excavated had a smooth, flat floor of stone slabs, evenly laid in sand. In this were drilled a number of round holes similar to those found in ancient Moqui sacred rooms, where they were symbolic of the entrance of the soul to the realms below. At one end of this room was a bench of slabs, probably a lounging place, built before the fire. The walls were formed of upright legs cemented with mud, recalling the kiva or sacred house described by Coronado, who visited these regions three centuries ago. Several rounded stones, the size and shape of a man's head, closely resembled one found in Moqui—120 miles away—used as a form upon which the ancients plaited their ceremonial masks and helmets of yucca.

"This ruin is certainly prehistoric. Nothing within it was of white man's manufacture. No walls were standing above ground. The town was originally a complete pueblo situated on a bluff above a small creek flowing into the Little Colorado. It was originally of regular rectangular form, probably several stories high, and built of stone. A large number of human skeletons were exhumed at this place, some from the bed of the river, which had probably encroached upon the town since it had been inhabited. The prehistoric population must have once numbered about 500—a large population for such cities. They doubtless deserted their houses in very ancient times. An ancient people not only inhabited its level portions, but cultivated the neighboring mountain sides. Remains of their gardens, marked by rows of stones, can be traced for miles. We also observed remains of irrigation ditches, etc."

The seats of ancient empires, and great and opulent cities, long buried from human ken, have been exhumed, and we of the present century have been made acquainted with ante-historic people and their civilization, of whose existence previous centuries never dreamed.

SIR ROWLAND HILL.

[Born 1795. Died 1879.]



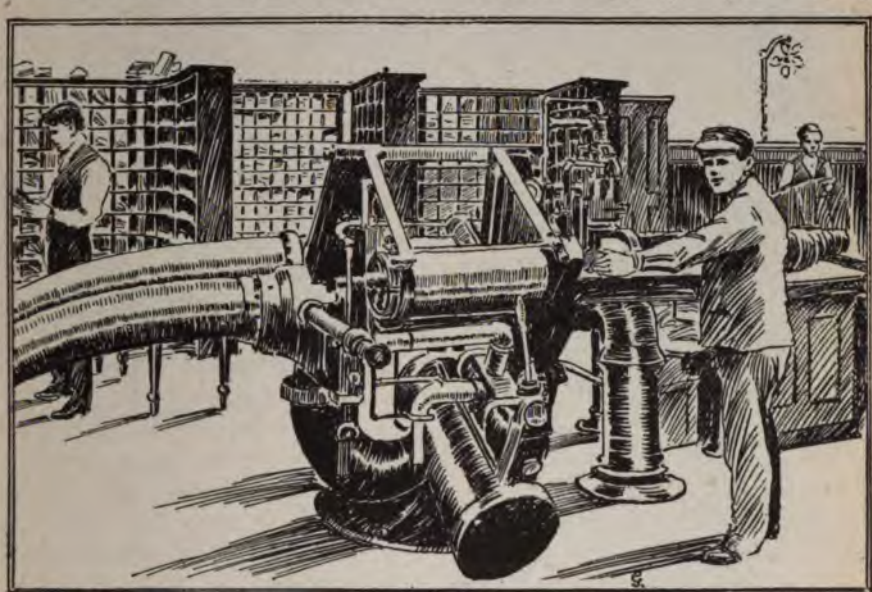
Penny postage is of course the great boon for which the name of benefactor is added to that of the inventor. But his beneficial services do not end with this great work. The present money-order system was also his suggestion; and many minor improvements of both departments, adding greatly to the efficiency of the service, emanated from his fertile and creative brain.

CHAPTER XXXI.

POSTAGE.

SIR ROWLAND HILL—POSTAGE REDUCED AND SYSTEMATIZED—STAMPS—ENVELOPES—POSTAGE ELEVATED INTO A SCIENCE SINCE 1800.

ONLY those past middle life have any idea of the great progress made in postal facilities during the passing half century. Little more than a half century since the postage on a single letter was so great that the poor could not afford the luxury, and any sort of correspondence by mail was a burden to even those in comfortable circumstances. Up to 1837 rates were so high as almost to forbid the use of the post-office by the poor, and injuriously to limit its use even for commercial correspondence. The conveyance of a single letter from London to such distances as Aberdeen or Belfast cost about 30 cents; from London to Brighton, sixteen cents. Double letters—that is, two sheets of paper—however thin or however weighty, were charged double postage. In defiance of law, vast numbers of letters were sent by carrier or other forbidden channels. Stamps and envelopes were unknown. The smallest note from a distant part of the country was charged thirty-seven cents and upward, a packet from Edinburgh to



SENDING MAIL FROM ONE CITY TO ANOTHER BY PNEUMATIC TUBE.

London costing three times as much as would now be charged for a letter to the Antipodes. One thing that added greatly to the burden of these charges was the usage of society. It was considered to be against good taste to prepay a letter, so that it was within the means of any one to victimize the person whom he selected as his correspondent. Many a poor man had to go without a meal to pay for a letter which he dare not refuse, lest it should contain news of vital importance to him.

In 1837 Rowland Hill (1795-1879) proposed, and in 1839 the British Parliament adopted, a reduction of postage to one penny (two cents) for all distances. Mr. Hill proposed that the rate of postage should be uniform, and charged according to weight, and that payment should be made in advance. The means of doing so by stamps was not suggested in the first edition of the pamphlet, and Mr. Hill said the idea did not originate with him. In a later issue the matter is thus referred to: "Perhaps the difficulties might be obviated by using a bit of paper just large enough to bear the stamp, and covered at the back with a glutinous wash, which by applying a little moisture might be attached to the back of the letter." This suggestion to use stamps originated with Sir Henry Bessemer, who really invented the postage stamp.

When the measure for the reduction of postage passed in Parliament, an offer was made by Government for plans for carrying it into effect. Mulready's envelope won the prize. It was so covered with the design that there was little room left for an address. Britannia sits enthroned, scattering letters to the four quarters of the globe. They were used two or three weeks, and then the post-office substituted the present stamp —"Queen's heads."

In this country, for the first third of a century, it cost twenty-five cents postage on a letter from Boston to New York. In 1840 reduction took place in the United States to a uniform rate of two cents. The reform revolutionized the world in the transportation of letters. Under the reduction the average letters per capita rose from four to thirty-three, and the revenue in proportion.

Mr. Hill was prompted to initiate the reform by learning that a brother and sister, too poor to pay the exorbitant postage, were in the habit of sending blank sheets to each other, and refuse to pay the postage, which in those days was not prepaid.

Of course, the post-office authorities opposed the reform. Lord Litchfield, postmaster-general, said in the house of Lords that of all the wild and extravagant schemes of which he had ever heard, it was the wildest and most extravagant. The reform was inaugurated on January 10, 1840. In 1839, 82,000,000 letters went through the British mails, including 5,500,000 franked letters which yielded no revenue. In 1875 more than 1,000,000,000 letters were posted, though the population was less than double that of 1839. The example of Great Britain has now been followed by the civilized nations.

Many curious incidents occurred

under the ancient postal rules. "The captain of a ship once posted for London a packet weighing thirty-two ounces, which came to the

ROWLAND HILL.

person to whom it was addressed charged with a postage of upward of $30, being four times as much as the charge for an inside place by the mail. So that had the captain, instead of posting the letter, sent a special messenger with it up to London, paying him handsomely for his time and for his traveling expenses, the result would have been a considerable saving. Another case of the same kind was communicated by Sir George Burgoyne to a friend of Rowland Hill: A packet of official papers was to be transmitted by one of our officers from a country town to Dublin; it seems that parcels for the mail were in that town received in the same shop as letters; and, either by mistake of the messenger or of the postmaster, this packet, which was meant to be a parcel, was forwarded as a letter. The charge was eleven pounds—that is, for a packet, which I could readily carry off in my pocket; an amount for which I could have taken the whole mail, places for four insides, and three out, with their portmanteaus, carpet-bags, etc. It must be remembered that at this time letters were chiefly charged, not by weight, but by the number of enclosures. Thus, a letter written on a single large sheet of paper, weighing perhaps nearly an ounce, was charged only a single postage, while a letter containing even the very slightest enclosure, however small might be its weight, was charged double postage."

In 1827 Brewer, in England, invented envelopes, hand-made. In 1840 a machine was invented, and perfected in 1845 by De la Rue. Toward the end of the year Captain Basil Hall (1788-1844), suggested mucilage on the flap of the envelope

A DEVICE FOR CATCHING MAIL BAGS.

instead of the wafer of wax usually employed. The book post was suggested by Hill in 1847. In 1870, in this country, newspaper postage

was reduced to one cent, and postal cards were introduced. Distribution of mail matter en route was introduced by Armstrong of Chicago.

The penny (two cents) postage that has prevailed in Great Britain and the United States, is about being extended to the British colonies, and bids fair ere the century ends, to be extended to the English-speaking world.

Rowland Hill was author of many inventions before his great benefaction to the world, such as "Pendulous Mechanism Applied to Steam-engines," "Propelling Steamboats by a Screw," "Plan for Checking the Speed of Stage Coaches," "Weighing Letters," "Assorting Letters in a Coach," "Telegraphs, by Pressure of Air, etc.," "Gas, for Distant Places, Compressed Along Small Pipes," "Road-making by Machinery," "A Cylinder Printing Machine," etc.

A machine for canceling, in the post-office, the work of G. W. Hey, Emil Laoss, M. J. Dolphin and August Bertram will cancel and postmark 40,000 letters an hour,—the most rapid printing machine in existence. An electric motor of eighteen horse-power drives the machine.

The postal service of the civilized world is one of the century's greatest achievements.

CHAPTER XXXII.

PHRENOLOGY AND MESMERISM.

BIRTH OF THE SCIENCE—GALL—SPURZHEIM—FOWLER—MESMER—HYPNOTISM.

PHRENOLOGY. This quasi science came into being with the century, and men were then first told that a relation exists between the several faculties of the human mind and particular portions of the brain, the latter being the organs through which the former act. That the brain, taken as a whole, is the part of the human body through which the mind operates, had been from ancient times the general belief; but the localization of the several faculties was first attempted by Dr. Franz Joseph Gall (1758-1828). He first promulgated his views in a course of lectures in his house at Vienna in 1796. He gained in 1804 a valuable coadjutor in Dr. Johann Kaspar Spurzheim (1776-1832), who journeyed with him in 1807 to Paris, where a commission appointed by the Institute reported very unfavorably of his system. When Spurzheim visited Edinburgh he met George Combe (1788-1858), who adopted his views, and in 1819 published Essays on Phrenology, ultimately developed into his System of Phrenology, which became very popular. Gall enumerated nearly thirty, Spurzheim thirty-five mental faculties which he considered as primitive. The brothers, L. N. and O. S. Fowler (1809-1887), succeeded Combe as the apostles of the new science.

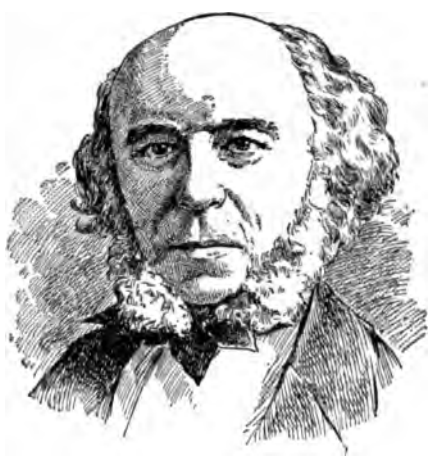
Mesmerism was announced as a science by Franz Anton Mesmer (1733-1815), a Swiss physician, and by him called Animal Magnetism. He thought that the stars exercised an influence over men, and identifying this with magnetism, sought to effect cures by stroking his patients with magnets. Finding that Gassner, a Swabian priest, effected cures by stroking with his hand, Mesmer abandoned the use of the magnets, persuaded that some mysterious force present in himself was the means by which cures were effected. In 1843 Baron von Reichenbach made public his views as to Odyl. The phenomena of animal magnetism, electro-biology, hypnotism, mesmerism, and odylic force are practically the same. Within the last few years they have been scientifically investigated, notably by Dr. Carpenter in England and by Prof. Weinhold and Dr. Heidenhain on the continent. The chief phenomena are a hypnotic state induced by the patient gazing fixedly at some bright object, or by passes made by the operator; muscular rigidity, sometimes to such an extent as to admit of the body resting supported only by the head and heels on two chairs, insensibility to pain, and perverted sensation, as exhibited in a hypnotized patient imagining water to be wine.

CHAPTER XXXIII.

EVOLUTION.

THE GREAT SCIENTIFIC DISCOVERY OF THE CENTURY—GOETHE—DARWIN—CUVIER—WALLACE—BUFFON—CHAMBERS — LAMARCK— PROTOPLASM—HERBERT SPENCER—TYNDALL—HAECKEL—HUXLEY—FISKE.

THE doctrine of Evolution, as now generally understood, originated in the conceptions of the great German poet, Johann



HERBERT SPENCER.

Wolfgang Goethe (1749-1832) about the year 1790. He saw that all the parts of flowers are modifications of leaves. The German naturalist, Lorenz Oken, or Okenfuss (1779-1851), reached the same conclusion at about the same time. From this it was generalized that all plants and animals have been evolved from a few types, or a single original type. Erasmus Darwin (1731-1802), author of the "Botanic Garden," cherished the same theory. A cognate theory, that of the transmutation of species had been held by Immanuel Kant (1724-1804), de Maillet, P. L. M. Maupertuis (1698-1759), Robinet (P. S.), La Place (1749-1827), and G. L. L. de Buffon (1707-1788). Up to the beginning of the present century, however, the theory was a tentative speculation. But in the brain of Jean Baptiste Pierre Antoine de Lamarck (1744-1829) the thought germinated, and he formulated it first in 1801, and later in 1809, and he gave his ideas of the causes of the difference between plants and animals, namely the efforts of each organism to fit its environment. La Place about the same time, in his

CHARLES DARWIN.

"Philosophie Zoologique," gave similar views. The great Cuvier (George Chretien Leopold (1769-

1832), and nearly all contemporary scientists, opposed the Lamarckian hypothesis and held to the immutability of species. But the new thought was germinating in other minds. Conspicuous among them was Goeffroy Saint Hillaire (1772-1844), and after a brief controversy the idea seemed to have been dropped.

But in 1844 an anonymous work appeared, now known to have been written by Robert Chambers, entitled "Vestiges of the Natural History of Creation," which made a great sensation, and similar ideas were avowed by Leopold von Buch (1774-1853), Joseph Leidy (1823-1892), and others. The new theory gained little acceptance until Charles Robert Darwin (1809-1882), grandson of Erasmus, after extensive observations and experiments, about 1844 reached the conclusions indicated by the stereotyped terms, "survival of the fittest," "natural selection," etc. He kept his discovery in manuscript by him unpublished for many years; meanwhile adding vast numbers of facts to those already gathered, and in 1858 a paper containing an abstract of his theory was presented to the Linnæan Society of London, together with one from Alfred Russell Wallace (1822), who had independently reached similar conclusions, and in 1859 Darwin's celebrated "Origin of Species" appeared, producing probably a greater sensation than any book has created in modern times. The theory of "Natural Selection" was at once accepted and advocated by the great botanist, Joseph Dalton Hooker (1817), by Charles Lyell (1797-1875), the famous geologist, by Asa Gray (1810-1888), John Tyndall (1820-1893), Herbert Spencer (1820), in 1852, Thomas Henry Huxley (1825-1895), E. H. Haeckel (1834-1894), John William Lubbock (1803-1865), and others.

The generally accepted theory is—for it is hypothesis, even yet—that variations in animal and vegetable life are produced by environment, and the struggle for existence, which, it is held, will account for all the differences of structure, etc. The beginning of life is not accounted for. Spontaneous generation, suggested by F. A. Pouchet (1800-1872), and H. C. Bastian (1837) were thoroughly disproved by Pasteur and Tyndall, who demonstrated that "spontaneous generation" is due to germs in the air. The primordial germ is unaccounted for, but Darwinians claim that all the variations from the lowest to the highest form of life are due to environment. There are chasms not bridged over, but the theory has been advocated with superb ability, and the hypothesis of evolution is one of the great scientific and intellectual achievements of the century. Darwin's "Origin" reached its eleventh edition in 1860.

The doctrine is one of the greatest scientific theories that the mind of man has ever conceived. It is as yet only a working hypothesis, but it is generally accepted, by scientists at least, as an hypothesis. It postulates the development of this world and of the solar system, if not of all stellar systems, from a fine mist or nebula. Professor Huxley

says: "Nor is the value of the doctrine of evolution, to the philosophic thinker, diminished by the fact that it applies the same method to the living and the non-living world, and embraces in one stupendous analogy the growth of a solar system from molecular chaos, the shaping of the earth from the nebulous cubhood of its youth, through innumerable changes and immeasurable ages to the present form, and the development of a living being from the shapeless mass of protoplasm we term a germ." In its extreme form it traces both the animal and vegetable kingdoms to one very low form of life, consisting of a minute cell, and supposes this cell produced by or from inorganic matter by some occult process formerly technically denominated spontaneous generation. Of this advanced school, Professor Haeckel may be taken as the representative. With a more moderate school of thought the great name of Darwin is associated. A living being of very simple and low organization, once obtained, all animals and plants were evolved or developed from it by the operation of natural laws. Some approach to the physical structure of man is supposed to be traceable in the humble and unarmored mollusks called ascidians, whence man's line of ancestry ran through the lower vertebratæ, the monotrematous mammals, other orders of the class, and finally the anthropoid apes. In this view both Darwin and Haeckel essentially agreed. In the long series of evolution, the continual tendency was for the simple to develop into the complex, or for an organ, which at first had several functions to fulfill, to become specialized. The more generalized forms are looked for in the older rocks, while as more and more recent strata are examined the organisms met with are those highly specialized. Evolution prescribes no limits to the perfection of bodily and mental organization which the human race may ultimately reach.

At the "World's Congress of Religions" (1893), a paper was read from Herbert Spencer, who said: "At a congress which has for its chief purpose to advance ethics and politics, by diffusing evolutionary ideas, it seems especially needful to dissipate a current misconception respecting the relation in which we stand, individually, towards the process of social evolution. Errors of a certain class may be grouped as errors of the uncultured, but there are errors of another class which characterize the cultured, implying, as they do, a large amount of knowledge with a good deal of thought, but yet, with thought not commensurate with the knowledge. The errors I refer to are of this class:

"The conception of evolution at large, as it exists in those who are aware that evolution includes much more than 'natural selection,' involves the belief that from beginning to end it goes on irresistibly and unconsciously. The concentration of nebulæ into stars and the formation of solar systems are determined entirely by certain properties of the matter previously diffused. Planets which were once gaseous, then

liquid, and finally covered by their crusts, gradually undergo geological transformations in virtue of mechanical and chemical processes."

Just before the publication of Mr. Darwin's first great work on the subject, the vast majority of naturalists believed that each species, whether of animals or of planets, was a separate creation. It was known that it might run into "varieties," might be improved by cultivation, or might help to originate a "hybrid" between it and another species, in which case the hybrid was sterile, but it was deemed quite a canon of natural science that it could undergo no farther change. Mr. Darwin followed a small but distinguished school of naturalists in setting wholly aside this canon, and accepting instead of it the transmutation of species. Mr. Darwin's views as to how species originated, arrived at independently about the same time by Mr. Alfred Russel Wallace, and foreshadowed by Aristotle, Matthews, and others, may be embodied in the following postulates or propositions: (1) That a certain amount of variability exists in every animal or plant. No children of the same parents are alike, and the circumstances of the life of each tend to increase the original variation. It is the same with animals and plants. Variation is so great under domestication that it has excited universal notice. Witness the case of tame pigeons, dogs, cats, or cattle. Similar changes go on at a slower rate in nature among wild animals and plants. (2) Animals and plants, when not checked in their increase, tend to multiply at a geometrical ratio. Malthus long ago pointed out that this is the case with man, and it is the same with inferior animals and plants. Each species would singly fill the earth were it not checked by others. (3) Hence there is a continuous struggle for existence among all organized beings in the world, individuals of each species battling against those of all other species, and yet more severely against those of their own. (4) Speaking broadly, those best adapted for the struggle will be the victors in it, while those less adapted to it will be defeated and die. This is called by Mr. Darwin, natural selection. (5) As the offspring of any animal or plant tends to be in most respects like its parent, and as the less improved forms are likely to be vanquished and perish, each race will ultimately be continued by the individuals in it more highly organized than the rest. Sexual preferences will produce a selection tending in the same direction. (6) The result will be an endless progression, evolving higher species, genera, families, orders, classes, if not even sub-kingdoms themselves, the infinitely varied forms being each adapted to the circumstances by which it is surrounded. Man is believed by Mr. Darwin to have possibly descended at a highly remote period from a "group of marine animals resembling the larvæ of existing ascidians" (a lowly type of mollusks).

Darwinism was and is, to a certain extent, misunderstood by the general public. When first it was

broached, it was held as teaching, among other views, that—

"A very tall pig, with a very long nose,
Puts forth a proboscis, quite down to his toes,
And then by the name of an elephant goes."

Here the transformation is in the lifetime of one animal. Mr. Darwin's transformations demand for their accomplishment vastly extended geological ages, and at the end of them the pig does not become the elephant. He held that at a remote point of bygone geological times an animal, which was neither a pig nor an elephant, but had the characteristics common to both, existed. It gave rise to more specialized forms the same process took place with them till the pig came at last from an ancestor not so specialized as itself, and the elephant from another. It is difficult, if not impossible, to harmonize Darwinism with the views regarding creation entertained by the great majority of the people; with theism it has not necessarily any controversy. With regard to the origin of life, Mr. Darwin believes that it may have "been originally breathed by the Creator into a few forms or into one." Thus not merely God, but a Creator, is recognized. — "Encyclopaedic Dictionary."

Charles Robert Darwin, M. A., LL. D., F. R. S., was the grandson of Doctor Erasmus Darwin, author of the "Botanic Garden," published in 1781; the "Zoonomia, or Laws of Organic Life," given to the world in 1796; and the "Phytologia, or Philosophy of Agriculture and Gardening," sent forth in 1800. The son of Dr. Erasmus Darwin was an eminent physician, practicing at Shrewsbury, England, in which town Charles Darwin was born in February, 1809. He was educated at Shrewsbury, Edinburgh, and Cambridge. He first became known through going (without salary) as naturalist with the Beagle surveying ship of war, which, between December, 1831, and December, 1836, circumnavigated the globe. In 1839 he married. Between 1842 and 1846 he published three important works, one of which—that on "Coral Reefs"—revolutionized the views till then held on the formation of the Pacific islands. On November 24, 1859, he gave to the world the first edition of his immortal work on the "Origin of Species;" on January 7, 1860, the second appeared. The work has been translated into most, if not all, civilized languages. In 1871 Mr. Darwin, in his "Descent of Man," extended the views advanced in the "Origin of Species" to the human race. His last great work, one announcing great discoveries, in connection with the earth-worm, was called "The Formation of Vegetable Mould." When the "Origin of Species" and the "Descent of Man" were sent forth, many replies were published by religious men who deemed his views completely antagonistic to revelation; but when he died on April 19, 1882, his merits were acknowledged on all sides.

Jean Baptiste Pierre Antoine de Mounet, Chevalier de Lamarck

(1744-1824), is regarded as the precursor of Darwin. His system (Lamarckism) considered that all organized beings were sprung from microscopic monads. If, when life

JOHN TYNDALL.

was established in a mass of amorphous matter, the mass was destitute of irritability, it became a vegetable; if it possessed irritability, it developed into an animal.

Herbert Spencer was born at Derby, in 1820, and was at first a civil engineer, but soon gave that up and devoted himself entirely to philosophy. He has always refused to enter into connection of any kind with the universities of his land, and he has spent his own fortune and all the income from his books in prosecuting his studies. He is the most comprehensive thinker of the century. In his writings he treated the whole universe from one standpoint, and has brought together and collected almost the whole sum of human knowledge.

PROTOPLASM.—It has been claimed, but the announcement is only given here tentatively, that there is a living matter from which all kinds of living beings are formed and developed, and to the properties of which all their functions are ultimately referred. It was first noticed and described by Roesel v. Rosenhof, in his account of the proteus-animalcule, and was named Sarcode by Deujardin in 1835. In 1846 v. Mohl gave the name Protoplasm to the "tough, slimy, granular, semi-fluid" portion of the contents of the vegetable cell. Cohn suggested the identity of vegetable protoplasm, and animal sarcode, which was established by Schultze, whose conclusions were probably aided by the researches of DeBary and Koelliker. Protoplasm is a transparent homogeneous or granular looking substance. Under high microscopic powers, in many instances, it shows a more or less definite structure, composed of fibrils more or less regular, and in some instances grouped into a honey-

THOMAS H. HUXLEY.

combed or fibrillar reticulum, in the meshes of which is a homogeneous interstitial substance. The closer the meshes of the reticulum the less there is of this interstitial

substance, and the more regularly granular does it appear. Water, dilute acids, and alkalies cause protoplasm to swell up and ultimately become disintegrated, and it is coagulated by those substances that coagulate proteids. The theory is here given for what it is worth, but this writer is forced to record the Scotch verdict, "Not Proven."

Everywhere experts are searching into the principles of things, and inventors have been devising practical applications of them. New departments of science have been evolved. Biology, Sociology, Anthropology, are recent additions to the list, while Chemistry, Meteorology, Magnetism, and other forms of energy have been rewritten. Especially has the correlation of the physical forces, motion, heat, light, magnetism, electricity, been demonstrated within the last half-century. Among the chief authorities in biology are Lionel S. Beale (1828), St. George Mivart (1827), who asserts evolution generally, but denies that it is applicable to the human intellect, or that "natural selection" is its cause, G. F. Romanes, Darwinian, etc.

One of the attempts of scientists to account for life without a Creator is given in the history of Bathybius, a slimy matter dredged up in the North Atlantic, in 1857, from a depth of 6,000 to 25,000 feet, by the crew of the "Cyclops," when examining what has since been called the "Telegraph Plateau," for the deposition of the Atlantic Telegraph cable. Specimens of this viscous mud, examined by Professor Huxley, in 1858, were re-examined by him with higher microscopic power in 1868, when he came to the conclusion that they contained a protoplasmic substance apparently existing in masses over wide areas of ocean-bottom. Minute bodies, which he had before called coccoliths, of two forms, were believed to stand to the gelatinous protoplasm in the same relation as the spicula of sponges to the softer parts of the animal. Professor Haeckel, after examining the slimy substance, adopted the views of Professor Huxley, and attributed the origin of the protoplasmic substance, though not dogmatically, to spontaneous generation. It was named after him, by Professor Huxley, Bathybius Haeckellii. The naturalists of the exploring vessel "Porcupine," in 1868, stated that they had found Bathybius alive, but considered it to be derived from sponges, etc. Those of the "Challenger," however, failed to find it in the parts of the ocean which they dredged over, and propounded the hypothesis that the Bathybius was nothing more than a precipitate from the sea-water by the alcohol in which the specimens had been preserved. The assumption that Bathybius is the source of life is one of the unfounded dreams of science.

Nothing in all the history of science is vaster in its range of thought, and in the wide field of speculation which it has mapped, than the biological discoveries and generalizations of the last half of this century. Darwin, Spencer, Tyndall, Huxley, and their colaborers have created a distinct literature.

THOMAS CAMPBELL.

[Born 1777. Died 1844.]

Let it be asked if those do not deserve well of their kind who enrich the language with such noble or graceful thoughts as have many of the world's poets. What men should be more highly esteemed as benefactors than such instructors, whether their appeal be directed to the heart or the intellect? Grant this, as few on reflection can fail to do, and it must be admitted how worthy of a place in this honorable list is he to whom the world owes "The Pleasures of Hope."

CHAPTER XXXIV.

MUSIC.

MUSICAL INSTRUMENTS IMPROVED AND INVENTED—HAYDN—BEETHOVEN—MENDELSSOHN—CHOPIN—SCHUMANN—WAGNER—VERDI—THE GREAT ORATORIOS AND OPERAS ALL THE CHILDREN OF THE NINETEENTH CENTURY.

GREAT progress had been made in music during the eighteenth century, in composition, vocal, and instrumental execution, and in the improvement of musical instruments, and instrumentation. Bach, Mozart, Händel, Haydn, Beethoven and Glück surpassed in genius any preceding or succeeding equal number of composers, and developed the science, and laid the foundation for the great achievements of what may be called the greatest century of musical development and accomplishment. But the Eighteenth Century was only lit up by a few bright, particular stars, whose radiance rendered more evident the "darkness visible" of the general sky. The following hundred years filled the firmament with galaxies where before were only scattered points of light. Such has been the improvement of instruments, the skill of performers, the development of vocal execution, the genius of composers, and the general elevation of musical taste and culture, that it may truthfully be said that in musical excellence the Nineteenth Century far surpassed all the preceding eighteen.

After John Sebastian Bach (1685-1750), Georg Friedrich Händel (1685-1759), Christopher Willibald Ritter Glück (1714-1787), and Wolfgang Amadeus Mozart (1756-1791), the great names among musical composers belong to the present century.

Though most of his life was lived in the eighteenth century, Francis Joseph Haydn, born near Vienna (1732-1809), comes within the time chronicled in this book, though he wrote his masterpiece, "The Creation," in 1795-8. Haydn's father was a wheelwright of musical turn, who played on the organ and harp, and sang tenor, and with his wife and son enjoyed their Sunday afternoon concerts. The boy soon became a choir-boy, and though required to practice but two hours daily, he voluntarily practiced from sixteen to eighteen hours a day for ten years. He perfected himself on the piano and the violin. He produced 119 symphonies, 83 quartettes, 24 trios, 19 operas, 15 masses, 163 compositions for barytone (an instrument now obsolete) and 44 piano sonatas—800 musical compositions in all. He executed his music on the piano with skill, and was the great master of his times. He towered above his contemporaries, and has had but few peers.

Ludwig von Beethoven was born

in Bonn, in 1770, and died in 1827. The world agrees that his is the greatest name in the annals of music. "Bach wrote more learnedly, Handel at times quite as heartily, Haydn as cleverly, and Mozart as sweetly, but what Beethoven does is to avail himself of all these excellencies of form and substance, in order to express feeling through them. The greatest of his predecessors, Bach, also had feeling and expressed it in his Passion music with great power. It is the proud pre-eminence of this master to have expressed his soul in music as fully and as exclusively as Shakespeare expressed his in his plays, or Raphael in his cartoons." Beethoven began to be deaf in 1800, and was totally so in 1810. But his musical genius was neither clouded nor obstructed by his infirmity. He gave new force and beauty to instrumental music. He produced works that will live as long as the soul of man is moved by "concord of sweet sounds." His nine symphonies have never been equaled. They are musical miracles. As Taine declares, "Dante, Shakespeare, Michael Angelo and Beethoven are the four greatest souls, possessing the highest order of genius."

Felix Mendelssohn was born in Hamburg, February 3, 1809, and died in Leipsic, Nov. 4, 1847. In later life he added to his own his mother's name, Bartholdy. He played the piano well at eight. At fifteen he brought out his fourth opera which was received with great applause. His "Elijah" ranks among the principal compositions of all time. His "Songs Without Words" will always charm the soul susceptible to the finest musical creations. The overture to "Midsummer Night's Dream" alone establishes his claim to be one of the few composers that occupy the first rank.

ORCHESTRA PLAYED BY MANIKINS.

Frederic Chopin was born near Warsaw, March 1, 1809, and died in Paris, Oct. 17, 1849. When only nine he improvised in public. At sixteen he was able to play all that had been composed for the piano,

had produced studies that are rded as ranking with the best of usic. His later compositions him among the masters, infer- o the greatest, yet one of the ortals.

bert Schuman (born in Saxony, 8, 1810, died insane, July 31, , like most of the great com- rs, evinced his genius early in He attempted to prepare for aw, but the attractions of music irresistible. He was already xcellent pianist, when an acci- disabled a finger, and he de- l his life to composition. In a e year he composed one hun- and forty songs. Among them man's Love and Life" and t's Love" are universally ad- d. An increasing malady of ncholy finally banished him to a te asylum in which he died. said of him, "Schuman thinks c better than any other since oven." His is emphatically usic of emotion.

anz Liszt, a Hungarian (1811- -), appeared in public as a pian- the age of nine. His first com- ion was in print, when he was twelve. As an artist on the , he has never been equaled. execution is wonderful. As a er he has never been surpassed. as enlarged the sphere of the -forte to limits beyond its pos- ties, in the estimation of all his ecessors. His generosity to the y has been great, and though a er for forty years, he never re- d any remuneration for his ser- . Among his pupils have been Bulow, Joachim, Remenyi, and other great performers. He is greater as an interpreter than as a composer, and yet his compositions are among the valuable musical treasures of the present age.

Wilhelm Richard Wagner, born in Leipsic, 1813, and died in 1883, is declared by his admirers to be the greatest of all composers, the Shakespeare among the masters of music. "Tannhauser," "Lohengrin", "Ring des Nibelungen," "Siegfried," "Die Meistersinger," "Parsifal," and other compositions demonstrate the unique and magnificent genius of their author, and if the universal suffrage of music lovers do not assign him to the altitude of Beethoven, and Mendelssohn, they will agree that his is one of the few names in the annals of music that will never die, while multitudes of music lovers award to him the supreme eminence in the world of music.

Giuseppe Verdi (1813-1897) has wonderfully enriched the world of music. Among his noted works are "Ernani," "Nabucodonosor," "Macbeth," "Rigoletto," "Il Trovatore," "La Traviata," "The Mask Ball," "Aida," and his "Requiem Mass." Verdi has been decorated with many of the grand orders of Europe. He was a tireless worker, and as late as 1886 and 1893, although a very old man, he wrote the grand operas of "Falstaff" and "Otello." In 1880 Verdi received the Order of the Crown of Italy. These names tell the story of what joy and peace and pleasure the genius of the Italian of humble origin has brought to his kind. Signor

Verdi is held by many to be the greatest of contemporary composers. His career as a writer of classic music covers a period that will encompass almost all of the musical celebrities of the century.

The average reader will be surprised to learn how large a number of the great composers have written in the present century. Michael William Balfe (1808-1870), author of "The Bohemian Girl," and other operas; Maria C. Z. S. Cherubini (1760-1842), one of the best of the Italian composers; Vincenzo Bellini, composer of "Norma," "Sonnambula," etc., born 1802, died 1835; Gaetano Donizetti (1791-1848), author of "Lucia de Lammermoor," etc., the immortal composer of "Faust," and many songs of highest merit; Francois Adrien Boieldeau, born 1775, in Rouen, died 1834, the greatest in the French comic opera, composer of the "Calife de Bagdad," etc.; Hector Berlioz (1803-1869), author of "The Damnation of Faust," and much of the grandest orchestral music; Johannes Brahms, one of the chief among composers, born in Hamburg, 1833, died 1897; Sir Michael Costa, born in Naples, 1810; Friedrich Flotow, born 1812, author of "Martha," etc.; Louis Joseph Ferdinand Herold (1791-1833); Giacomo Meyerbeer (1791-1864), composer of "Robert der Teufel" "Les Huguenotts," etc., and ranking among the really great composers; F. M. Victor Masse (1822-1884); Frederick Massenet (1842); Jacques Offenbach, born in Cologne 1819, author of more than a hundred superior works; Gasparo Luigi Pacificus Spontini (1774-1851), among Italy's greatest opera composers: Camille Saint-Saens (1835); Gioachirno Antonio Rossini (1792-1868), who wrote the opera "Tancredi" in his twenty-first year, and subsequently "The Barber of Seville," "Othello," "Moses in Egypt," "William Tell," etc. Franz Peter Schubert (1797-1828), who composed more than six hundred songs, and masses, symphonies, etc., which enroll him among the great masters of musical conception and expression; Johann Strauss (1804-1849), author of some of the most beautiful dance music ever written; his son Johann, composer of the world-famous waltz, "The Beautiful Blue Danube" (1825-1899); Joachim J. Raff, born in Switzerland May 12, 1822, author of music known and prized throughout the world, symphonies, overtures, songs, etc.; Charles Ambroise Thomas (1811); Carl Maria von Weber (1786-1826), composer of "Der Freischutz," and other great music, and the first great composer and player of the "romantic" school.

Perhaps the following names belong in a lower class, though they have contributed immensely to the music of the century. Franz Abt (born December 22, 1819), composer of "When the Swallows Homeward Fly"; Auber (1784-1871); Thomas Atwood (1767-1838), author of dramatic and sacred music; John F. Barnett (born October 6, 1838), composer of cantatas, overtures, etc.; Sir Julius Benedict (born 1804), author of several operas and oratorios, who was with Jenny Lind in America, in 1850; William Stern-

dale Bennett (1816-1875), one of the greatest of English composers; Sir Henry Rowley Bishop (1786-1855); Max Bruch (1838), whose "Loreley," "Frithjof," "Flight of the Holy Family," etc., prove his musical abilities to be of a very high order; Dudley Buck, born in Connecticut in 1838, greatest of living American composers for the organ; John W. Callcott (1766-1821); Felicien David (1810-1876); Heinrich Ludwig Edmund Dorn, born November 18, 1804; Robert Franz, born in 1815, author of a large number of songs of a high order; Neils Gade, born in 1817, in Copenhagen, and one of the greatest of modern composers; Thomas Greatorex (1758-1831), organist of Westminster Abbey, and author of church music; John Liphot Hatton, born in Liverpool in 1809, one of England's chief composers; Ferdinand Hiller, born in Frankfort, Germany, 1811, who ranks high among the great composers; Joseph Phillip Knight, born in England in 1812, author of "Rocked in the Cradle of the Deep"; Ed. Kretschmer, born in 1830, is one of the chief composers of the times; Charles Lecocq, born in Paris in 1832, author of "La Fille de M'me Angot"; Claude Joseph Rouget de L'Isle, born in 1760, died 1836, author of the "Marseilles Hymn"; Charles Francois Gounod (1818); J. N. Hummel (1778-1837); Sigismund Chevalier Newkomm (1778-1858); Ignatz Pleyel, born 1757, the twenty-fourth son of his father, died 1831; Friedrich J. C. Schneider (1786-1853), who wrote nine oratorios, thirteen masses and numerous operas, overtures, etc.; Louis Spohr (1784-1859); Gasparo Luigi Pacificus Spontini (1774-1851), one of Italy's great composers; Peter Tschaikowsky (1840), E. A. McDowell (1861).

The foregoing, besides a multitude of others—for this account can only mention the principal ones—have contributed to make an array of musical composers not equaled by all the preceding centuries. And it should be added that their labors have been supplemented by many who have done much to popularize and extend the knowledge, practice and enjoyment of music.

It would be impossible to chronicle here the host of those who have contributed to extend the knowledge and practice of voice and instrument, or who have composed music more or less excellent. The following are representative names: B. F. Baker (1820), T. J. Bethune ("Blind Tom"), Anna Bishop, Maria Litta, the Hutchinson Family, W. O. Perkins (1829), H. S. Perkins (1833), J. E. Perkins (1845), Adelaide Phillips (1833-1882), Arthur S. Sullivan, composer of "Pinafore" and other comic operas (1842), E. Seguin, Emma Thursby, C. Zeuner, etc.

No age ever equaled the Nineteenth Century in the number of singers who have interpreted the themes of the great tone-masters. Among these should be named Emma Abbott (1849-1891), Marietta Albani, the greatest contralto of the age, born in Italy in 1824; John Braham (1774-1856), the wonderful English tenor; Caradori-Allan (1800-1865), Annie Louise Cary, contralto, born in Maine in 1846;

Angelica Catalini, born in 1779, died, 1849, a marvelous soprano; Mario Bordogni (1788), a great singer; C. B. Incledon (1763-1826); Italo Campanini, born 1846, who sang with great effect in eighty operas, which he knew by heart; Edward Phillip Devrient, a great baritone, and friend of Mendelssohn, born in 1801; Jean Baptiste Faure, born 1830, a great baritone; Madame Schroder Devrient (1804-1860); Karl Formes, born 1810, a grand bass singer; Manuel Garcia (1775-1832), renowned as a singer and composer; Guilia Grisi, born in 1810, died 1869; Minnie Hauck, 1852; Catharine Hayes (1825-1861); Edouard and Jean De Reszki; Clara Louise Kellogg, born in 1842, whose voice was of great range and excellence; Luigi Lablanche (1794-1858), greatest basso in Europe for forty years; Jenny Lind (Goldsmith), born in 1820, probably as great a soprano as was ever heard; Anna La Grange, born in 1825, a great soprano; Maria F. Malibran, born in 1808, died in 1836, one of the world's greatest sopranos; Conte di Camdia Mario, chief tenor of the operatic stage for thirty years, born in Genoa in 1812; Amalie Materna; Christine Nilsson, born in 1843, and the great Melba; Carlotta Patti, born in 1840, a brilliant singer, and her sister, Adelina, born in 1843, one of the three or four of the greatest singers that ever lived; Ciudetta Pasta, born in 1798, died in 1865, the most marvelous singer during the first quarter of the century; Euphrosyne Parepa-Rosa, born in Edinburgh in 1836, died 1874, an unsurpassable voice; J. Sims Reeves, born in 1822, the greatest of tenors in opera oratorio, or song; Giovanni Battista Rubini (1795-1854), the greatest tenor in the world during his lifetime; Henrietta Sontag (1805-1854), one of the greatest of the world's operatic singers; Anton Tamburini (1800-1876), a marvelous baritone; Theodore Wachtel, born in 1823, a wonderful tenor, etc.

The principal instrumental performers of the century besides those more celebrated as composers before mentioned, have been on the violin: Nicholas Paganini (1784-1840), greatest of all violinists; Ole Bull (1810-1880), Charles Auguste de Beriot (1802-1870), Ferdinand David (1810-1873), a celebrated virtuoso, who taught Joachim, Wilhelmj, and most of the great modern performers; Joseph Joachim, born June 28, 1831, greatest of living performers; Johann Christoph Lauterbach, born July 24, 1832; Eduard Remenyi (1830-1898), one of the greatest of living performers on "the king of instruments"; Henry Vieuxtemps (1820-1881), August Emil Daniel Friedrich Victor Wilhelmj, born in 1845, second only to Paganini, etc.

On the pianoforte, Hans Guido von Bulow (1830), Hans von Bronsart, born 1830; Muzio Clementi (1752-1832), J. B. Cramer (1771-1858), J. L. Dussek (1761-1812), J. M. Hummel (1770-1837), John Field (1782-1837), founder of the nocturne; Karl Czerny (1791-1857), Louis Moreau Gottschalk (1829-1869), Charles Halle, born April 11,

1819; Ignatz Moschelles (1794-1870), Anton Gregor Rubinstein (1829), greatest living pianist; Carl Tausig (1841-1871), one of the chief pianists; Sigismund Thalberg (1812-1871). Next to Rubinstein is Ignace Paderewski. What he has originated, coupled with his power as a performer, must ever preserve his name so long as the traditions of music survive; Moritz Rosenthal, etc.

On the organ, William T. Best, born 1826, Hiram Clarence Eddy, born 1851.

On the double bass, Domenico Dragonetti (1755-1846), Miller, Botterini, etc.

On the harp, Robert N. C. Bochsa (1789-1855.)

On the flute, Theobold Boehm (1802), inventor of the Boehm flute; are memorable names.

The reaction against popery and episcopacy had produced such prejudice after the time of Charles I, of England, that musicians and choirs were at a discount among the early pilgrims and puritans in this country, and it was not until the seventeenth century was well advanced that encouragement was given to either secular or sacred music. The second book printed in America was in Boston, the "Bay Psalm Book," in 1640. During the eighteenth century several music books were published, and in 1742 the first organ was built, in Boston, by Edward Bromfield. After the middle of the century an increasing number of books appeared, mostly containing very crude tunes, and hymns to match. In 1753 the first choir was introduced, but choirs were not general until 1790.

The first composer of sacred music of note in this country was William Billings(1764-1800), who was followed by AndrewLaw (1748-1821), Jacob Kimball (1761-1826), Oliver Holden, Samuel Holyoke (1771-1816), author of "China," and "Poland." Daniel Read, Oliver Shaw, Timothy Hastings (1787-1872), Jacob French, etc. The music of these men bears the relation to the works of their successors that the work of the early settlers does to the labors of the more advanced civilization of to-day.

The early part of the century witnessed the appearance of a large number of music books in this country, the formation of singing societies, and an increasing musical taste among the people. The most influential event was the organization of the Boston Handel and Haydn Society, March 30, 1815.

The mainspring of the great musical movement in this country that the Nineteenth Century has witnessed, was Lowell Mason, who was born in Medfield, Massachusetts, January 8, 1792, and died in 1872. He worked longer, harder, and more widely to create zeal in reading music for the sake of singing real chorals at church than any other man ever worked in any land. He hardly did a frivolous thing in his life. Think of the tunes "Rockingham," "Hebron," "Ward," "Boylston," "Naomi," "Downs," "Harwell," "Haddam," "Uxbridge," "Meribah," "Cowper," and the long list of serious

tunes which fit the hymns our fathers sang to them, and that we sing to them. Mason's "Juvenile Lyre," 1830, was the first collection of school songs ever published. After Mason came such musical men as William C. Woodbridge (1794-1845), George J. Webb, author of "The Morning Light is Breaking"; Luther Orlando Emerson (1820), who compiled five music books, and wrote "We Are Coming, Father Abraham"; Whittier's "Negro Boatman's Song," and others; Horatio Richmond Palmer (1834), author of some thirty music books; H. K. Oliver, author of "Federal Street"; Phillip P. Bliss (1838-1876), author of "Hold the Fort," "Only an Armor Bearer," "Pull for the Shore," "Rescue the Perishing," etc.; J. P. Webster (1830-1877), author of "The Sweet By and By"; H. P. Main (1839), I. D. Sankey (1840), Philip Phillips (1834), Stephen C. Foster (1826-1864), author of "Were a Million in the Field," "Stand by the Flag," "Old Folks at Home," and "Oh, Susannah," etc.; Hart Pease Danks (1834), author of "Anna Lee," "The Old Lane," "Silver Threads Among the Gold," "Not Ashamed of Christ," etc.; Will S. Hayes (1837), author of "Write Me a Letter from Home," "Parted by the River," etc.

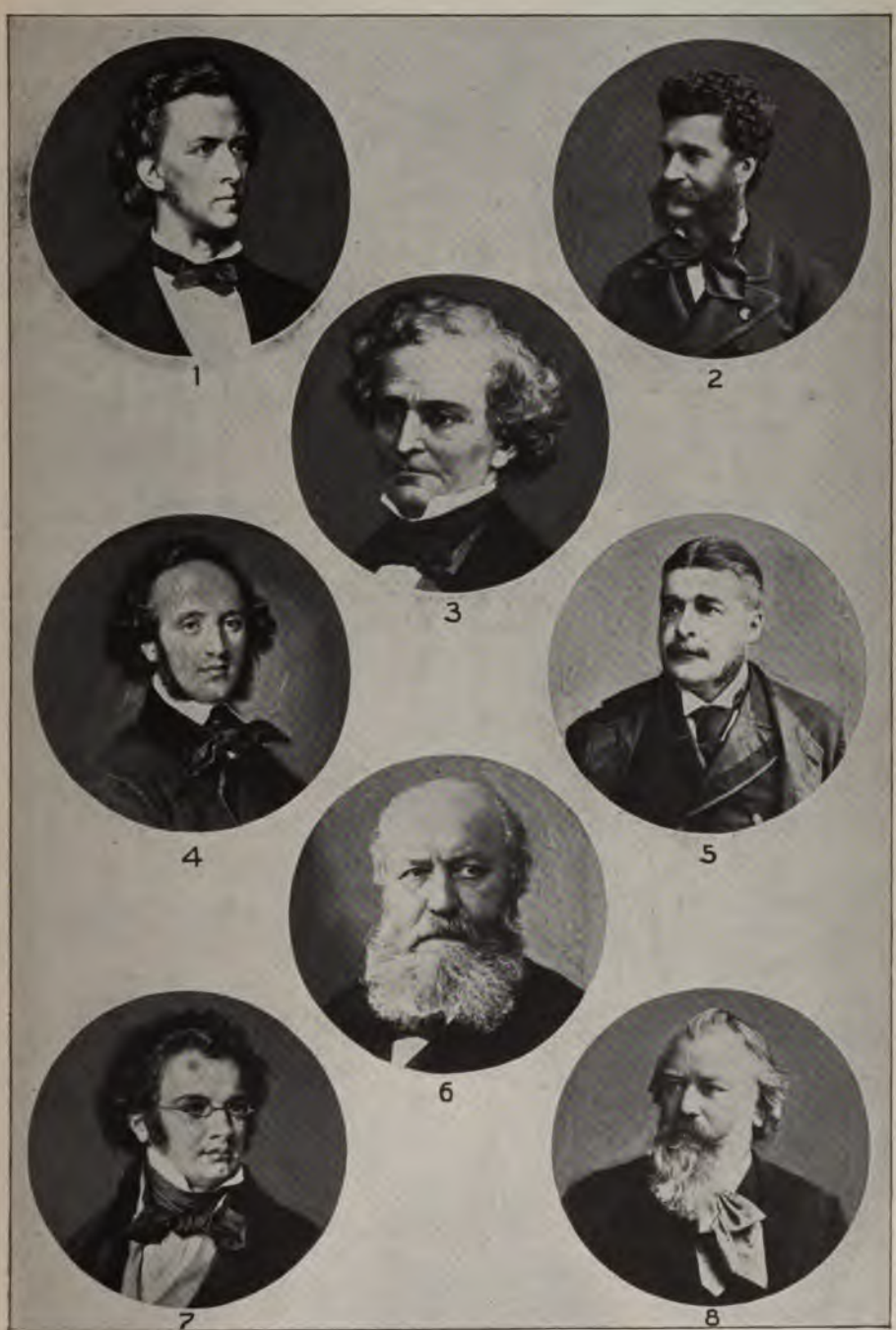
The great patriotic song of the century was produced in 1814, by Francis Scott Key (1779-1843), "The Star Spangled Banner." He was probably not author of the air, which is said to be an Irish melody.

John Howard Payne (1792-1851) deserves a paragraph by himself. He wrote a song for all nations and all times, "Home, Sweet Home." It was in an opera of his own composing "Clari, the Maid of Milan" (1823), and ranks as a domestic ballad with Key's "Star Spangled Banner" as a patriotic anthem.

The Civil War produced many great lyrics, whose authors deserve record. George F. Root (1820-1897), author of "Battle Cry of Freedom"; Charles Carroll Sawyer (1833), author of "Mother Would Comfort Me"; Henry C. Work (1832-1884), author of "Kingdom Coming," "Babylon is Fallen," "Marching Through Georgia," "Grandfather's Clock," and many others; H. L. Schreiner (1832), "The Wearing of the Grey," etc.

Since the war music has enjoyed a great revival. The chief singers and instrumentalists of the world, and the great oratorios and operas, songs and ballads of all time have been heard, musical instruments have multiplied to the remotest hamlets; amateurs with violin and piano, who fifty years ago would have been professionals, are found in all communities, and the musical taste has everywhere been elevated.

The first war song written during the Rebellion was "The First Gun Is Fired: May God Protect the Right," by George F. Root, of Chicago. The next one he wrote was "The Battle Cry of Freedom." There is some question as to which was the more popular, "The Battle Cry of Freedom" or "Tramp, Tramp, Tramp, the Boys Are Marching," composed by the same author. Another immensely popular song



1. Frederic F. Chopin. 2. Johann Strauss. 3. Hector Berlioz.
4. Jakob L. F. Mendelssohn. 5. Sir Arthur Sullivan.
6. Charles F. Gounod. 7. Franz Peter Schubert. 8. Johannes Brahms.

LISZT AND WAGNER.

was "When This Cruel War is Over," by Henry Tucker, followed closely by "Tenting on the Old Camp Ground," by Walter Kittridge. One of the most thrilling songs of the war was "Marching Through Georgia," by Henry C. Work, who also wrote "Kingdom Coming," "Babylon is Fallen," "Wake Nicodemus," "Ring the Bell, Watchman," "A Thousand Years," etc. Julia Ward Howe's "Battle Cry of the Republic," was probably the most popular song ever written by a woman. "Dixie" was composed, words and music, back in the early fifties, by Dan D. Emmett, the actor. Emmett had traveled in the South with a circus and had heard the performers speak of the country south of Mason and Dixon's line as "Dixie Land". "The Bonny Blue Flag" was composed by an Irish comedian named Harry McCarthy, and sung for the first time by his sister, Miss Marian McCarthy, in a New Orleans theater. "My Maryland" was one of the most beautiful war poems of the South, but it could never be set to catchy music. It was written by James R. Randall, a native of Baltimore, a distinct contribution to the "lost cause."

Among the modern pianists should be named Louis M. Gottschalk (1829-1869), Teresa Carreno (1853), Julia Rive-King (1857), Carlyle Petersilea (1844), Amy Fay (1844), Neally Stevens (1868), A. W. Doerner (1852), J. D. Buckingham (1855), M. Epstein (1855), A. J. Epstein (1857), Paderewski, Moritz Rosenthal.

Among the principal American-born singers not before named are Helene Hastreiter (1858), Minnie Hauk (1853), L. W. Wheeler (1837), Marie Litta (1856-1883), Ella Russell, Alice Ryan, Pauline L'Allemand, Lillian Norton-Gower, Lillian Russell, Myron W. Whitney, (1836), Emma Wixom (Nevada) (1860), Grace Hiltz (1854), Marie Van Zandt (1861), Emma C. Thursby (1857), Sybil Sanderson (1865), Emma Eames (1867), Jessie Bartlett Davis (1860), H. C. Barnabee (1820), Ellen Beach Yaw.

Organists and other performers have been produced in great numbers in this country. Prominent among them (native born) are John Hervy Wilcox (1827), Samuel P. Warren (1841), Clarence Eddy (1851), George E. Whitney (1842), Harrison M. Wild (1861), Henry M. Dunham (1853), Nathan H. Allen (1848), I. V. Flagler (1842), Henry S. Cutler (1825), S. B. Whitney (1842), Dudley Buck.

The names of Theodore Thomas (1835), our great national teacher in orchestral music, born in Essen, Hanover, October 11, 1835, one of the greatest conductors of orchestras, who has done much to educate the American people in music; P. S. Gilmore, William Laurence Tomlins (1844), Eben Tourjee (1834), Hans Balatka (1828), and Max Maretzk (1821), should be remembered as among those who have elevated the musical taste of the century.

Reginald de Koven (1859) is author of the operas "The Begum," and "Don Quixote," and much other music.

Among the great promoters of

musical advancement in this country was Dwight's "Journal of Music," published in Boston from 1852 to 1883, by John Sullivan Dwight (1813-1899).

The street organ was invented by Hicks, at the beginning of the century.

The concertina was originated by Sir Charles Wheatstone in 1829. It is of the seraphine family.

The double flageolet was invented by Bainbridge, about 1800.

There was never a period in Europe or America when the piano and violin were in such general use as now; when the number of vocal and instrumental performers was relatively so great; when the knowledge of music was so general; and though composers and performers of surpassing genius are not as numerous in the latter part of the century as earlier, yet the percentage of musicians, especially of amateurs and virtuosi, is larger than at any preceding epoch, while the enlargement of the range and scope of musical expression, especially in instrumentation, has been greater in the Nineteenth than in any other century. Never were the possibilities of opera, of oratorio, and song so great; never has their range been so wonderfully enlarged. In fact, grand opera originated in the present hundred years, and the great operas have been produced within that time, such as Spontini's "Vestali," Auber's "Massaniello," Rossini's "Tell," Meyerbeer's "Huguenots," Weber's "Der Freischutz," and Wagner's great works, as well as most of the great operas. And, though the oratorio had been developed to a wonderful degree in the eighteenth century, yet Haydn "Creation," Beethoven's "Mount Olives," Mendelssohn's "St. Paul Berlioz's "Damnation of Faust and many productions of lesser fame have all been given to the world since the present century began.

Other music has been produced in great quantity, the knowledge and ability to execute which has descended more and more to the masses of the people, who everywhere in the civilized world are more musical than ever before.

The spinet and harpsichord, the predecessors of the piano, and the piano, were comparatively inferior instruments until 1808. J. S. Broadwood in 1804 carried the compass to F, and applied tension bars. Erard, in 1808, substituted metal studs for the pinned wooden bridge. In 1800 Hawkins built the first upright pianoforte.

Subsequent improvements have been made, such as tension bars, metal tubes and plates, the recoil hammer (1821-7), and the power of the instrument was also made greater. The ancient instrument could not resist the tremendous strain of the great players. When Liszt began to perform at concerts, several pianos were always held in reserve to supply those he disabled. The first American piano was built in 1803 by Benjamin Crehorne, Milton, Massachusetts. In 1837 Jonas Chickering, of Boston, produced a perfect square iron frame, in place of the imperfect ones of Alpheus Babcock (1821) and Conrad Meyer

(1833). Chickering began the piano business in 1823. In 1855 Steinway and Sons produced the first overstrung scale. Other improvements have been made, mostly by American inventors, until the modern piano is wonderfully improved in range, power and sweetness over the five octave instruments with which the performers of the last century amazed their hearers. The pianoforte is the perfected form of all the ancient instruments, which consisted of strings struck by hammers. Originally the strings were placed in a small and portable box, and struck by hammers held in the hands. In this early shape, known as the "dulcimer," the instrument can be traced in nearly every part of the globe. The dulcimer was also called psaltery. The name given to the first instrument with keys acting on hammers was clavicytherium, or keyed cithara, which was introduced in the fifteenth, or early in the sixteenth, century; next came the clavichord, or clarichord, sometimes called monochord, in which quills plucked the strings; the virginal soon followed, which was an oblong instrument; this was soon followed by the spinet, of similar construction but generally triangular in shape; then came the harpsichord, a vast improvement on its predecessors, having a more extended compass and often two manuals. The earliest form of pianoforte, early in the eighteenth century, was perhaps, in some respects, inferior to a fine harpsichord, but it possessed the elements of expansion, as now exhibited in a modern grand pianoforte. The pianola is a recently invented wonder. Attached to a piano, by means of perforated cardboards, a child can perform the most difficult music.

Jonas Chickering (1798-1853) made great improvements in the king of instruments. Seventy-five years ago the pianoforte was a wretched piece of mechanism compared with the superb instrument of to-day. It was originally a progressive growth from the ancient lyre, through the harp, psaltery, dulcimer, clavicytherium, clavichord, virginal, spinet, harpsichord, to the piano of Christofali in the early years of the last century. In the old pianos, the frames were of wood, and it was impossible to use any but small, short strings. Fullness and power were not to be thought of, and builders were obliged to confine themselves to securing truthfulness of tone. Changes of weather rendered it impossible to keep the old-fashioned instrument in tune. In 1838 Jonas Chickering perfected his plan for preserving the permanence and purity of the tone of the instrument by casting the iron framing with the parallel bars in one piece. Iron had for some time before this been in general use for framing, but the frame was cast in a few separate parts, which were put together by means of bolts and screws, a plan which is still used to a considerable extent in Europe. By this plan of casting the frame and the supporting bars in one piece, Mr. Chickering not only prevented the frame from yielding to the pull of the strings, thus securing permanence

and purity of tone, but was enabled to use larger frames and more strings, which greatly increased the capacity of the instrument.

The first organ in America was in Queen's Chapel, Boston, and was used from 1714 to 1756. Some of the greatest organs ever manufactured have been produced in this country.

The American reed organ has become a popular instrument all over the world, and is found in city, village, hamlet, and farm house in every quarter of this country. The first step in its development was taken by a workman in Alexandre's harmonium factory, in Paris, in 1835, who afterwards went to America. Jeremiah Carhart invented the "exhaust bellows" in 1846, and produced the "melodeon." In 1848 Emmons Hamlin discovered a method of voicing the reeds, which resulted in the fine instruments now produced by Mason and Hamlin, and other manufacturers. They were first called "organ harmoniums," and afterwards "cabinet organs." Riley Burdett discovered the same improvement at the same time. Monroe, Needham and others have contributed in the production of this popular instrument. The harmonium was produced by Grenie early in the century. It was improved by Eschenbach, in 1814, by Schlimbach in 1816. The melophone came in 1855, after the seraphine in 1839. From these was evolved the reed organ.

Among the musical instruments invented this century are the accordion, a well-known keyed instrument with metallic reeds, whose sounds are produced by the vibrations of the several metallic tongues. The accordion was introduced into America from Germany about A. D. 1828. Improvements have been made on it in the flutina, the organ-accordion, and the concertina.

The sax-horn or sax-cornet is named after its inventor, who patented it in 1845. Charles Joseph Sax (1791-1865), a celebrated Belgian musical instrument maker, whose work in the improvement of brass instruments was carried on by his son, Antoine Joseph (born 1814). It is a group of six or more brass instruments with valves. It is a new kind of bugle, and the saxo-tromba (a family of cylinder instruments intermediate between the sax-horn and the cylinder trumpet). There are also six or seven different saxophones, all by Sax.

The banjo is an American invention. The ultimatum valve cornet was invented by C. G. Conn (1844), also a brass clarionet. The enharmonic organ, the harmonium, the Boehm flute, the æolian, the vocalion, the polyphone, the gramaphone are all of this century.

The Kent bugle is a keyed bugle introduced by the bandmaster of an Irish regiment in the British army, James Halliday, about the year 1814 or 1815, and called the Kent bugle out of compliment to the Duke of Kent, the father of Queen Victoria.

The æolian is an organ whose execution is produced, not by the player's fingers, but by perforated cards, each one of which in an ingenious way will produce a perfect

piece of music. Any piece ever composed can be rendered by a child or any one entirely unskilled, so that any home can enjoy as fine organ music as the most skilled organist can produce. The vocalion, the pianola, the æolian, enable organists and pianists, without musical skill, to surpass all but the most accomplished performers. The secret of the pianola is this—instead of playing with ten fingers (stiff and unruly fingers, too), you play with sixty-five pneumatic fingers, each one light as a feather and yet possessing enormous striking power.

Among modern wonders are the polyphone, the "wonderful banjo," and other instruments whose power and execution seem like magic. They reproduce the most complicated compositions. (See "Electricity.")

The lovers of music, who listen to bands, may not realize that the strains that delight them are due largely to instruments that have been invented, or at least greatly improved, by effective attachments, such as piston valves, etc., during a comparatively few years. Such as the alto clarionet, the bass clarionet, the different saxophones, the autoniophone, the duplex-euphonium, the trombone, cornet, etc.

One kind of music is peculiar to this generation, and is one of the most useful as well as one of the most popular products of the musical art, and that is sacred juvenile or Sunday-school melodies. Hundreds of volumes running into millions of copies have been issued and circulated. Much of it is ephemeral, but it is "catchy," and has been sung by children with great interest and delight, and has added immensely to the life and success of Sunday-schools. Bradbury, Root, Emerson, Bliss, Sankey, Straub and many others have been contributors to Sunday-school music, for music for the children was never thought of before the Nineteenth Century came, and it has done much to plant a love and knowledge of music in the young.

Before the present century the only music tolerated in religious worship was the solemn psalm or hymn tune, the stately chant, or the anthem. But towards the middle of the century livelier music began to be heard in the conference or devotional meeting, music that stimulated the emotions, stirred the feelings and warmed the heart. "Old Hundred" and "China" gave way to "There is a Happy Land," and later to "Sweet By and By." Bliss, Sankey and others married lively verse to livelier music, sometimes at first to music so secular that it seemed almost profane, but as Wesley said, "the devil ought not to have all the good music," and the movement has continued until the present, and such music as once would have driven all worship out of the church is now everywhere heard, and Christian devotion is quickened as "Hold the Fort," "Breast the Wave, Christian," and an immense number of stirring airs carry devotional songs, in the religious gatherings of Christian people.

In August of 1807, Francis Brown, in an address before the Handel So-

ciety of Dartmouth College, assails the prevailing style of church music and explains its shortcomings by saying that, "The greater part of those in our country who have undertaken to write music have been ignorant of its nature. Their pieces have little variety and little meaning. . . As they are written without any meaning they are performed without expression. . . . Another very serious fault in the greater part of American music denominated sacred, is that its movements and air are calculated rather to provoke levity than to enkindle devotion." Brown claims for American musical talent as much merit as attaches to that of the Europeans, but he says: "Our best musicians, instead of being awakened to exertion by call for splendid talents, have been discouraged by the increasing prevalence of a corrupt taste." He traces this evil to these causes: First, the passion for novelty; second, the antipathy of the higher classes, more particularly ladies, to taking part in the music of the sanctuary; third, the lack of attention to the character and qualifications of the instructors.

The contrast between the condition of music at the beginning of the century and at its close may be gauged if we will consider the almost universal diffusion of the art, both vocal and instrumental, at the present time, and its crudeness a hundred years ago.

HANNAH MORE.

[Born 1745. Died 1833.]

Although the present century has been remarkable for the number of women who have joined the band of those whose lives are spent in efforts to ameliorate the condition of their fellow creatures, not one has arisen whose work and influence can be said to have eclipsed the name of Hannah More,—a name which still remains a household word, even with those who take but little interest in the works of charity and benevolence which have made that name so familiar.

CHAPTER XXXV.

ART.

THE GREAT PAINTERS AND SCULPTORS OF THE GREATEST OF THE CENTURIES, — MANY NAMED—MUNKACSY — VERESCHAGIN—ROGERS—ST. GAUDENS—ALLSTON—CHURCH—MORAN—ETC.

THE century has yielded not only a great array of artists, painters, sculptors, etc., but some of the greatest the world has seen. If Phidias and the ancient sculptors have not been equaled in the Nineteenth Century, certainly great achievements of the chisel have been wrought by such artists as J. Nollekins (1737-1823), J. John Flaxman (1755-1826), A. Canova (1757-1822), F. J. B. Bosio (1769-1845), A. B. Thorwaldsen (1770-1844), L. Bartolini (1770-1850), John Gibson (1781-1866), Margaret F. Foley, Hiram Greenough (1805-1852), Hiram Powers (1805-1873), John Bell (1811), Thomas Crawford (1813-1857), Clark Mills (1815-1883), W. W. Story (1819-1895), J. L. Gerome (1824), Benj. Paul Akers (1825-1861), Randolph Rogers (1825-1892), John Rogers (1829), Harriet G. Hosmer (1831), John Hutchinson (1832), J. E. Boehm (1834-1890), Edward Kemys (1843), Vinnie R. Hoxie (1846), Douglas Tilden (deaf mute), Augustus St. Gaudens (1848), and a large number of whom the above named are representative.

Edward Kemys has won a unique position among artists by sculpturing remarkable statuary of the wild carnivora of America fauna. He has studied each animal in its native *habitat*, and reproduced it in marble that seems alive.

John Rogers is the author of the well-known Rogers groups of statuary. His "Checker Players," "The Slave Auction," and many others are genuine works of art. His statue of General Reynolds in Philadelphia is among the best works of the kind. He was born in Salem, Mass.

Augustus St. Gaudens was born of French and Irish parents. Beginning as a cameo-cutter, he developed into a sculptor, and his works demonstrate a high order of genius. His "Lincoln" and "Logan" have rarely been equaled as works of art.

Harriet G. Hosmer was born in Watertown, Mass. (1831). In childhood she showed her talent by modeling horses and other animals. In 1851 she executed her first work, a head of "Hesper." Since then she has achieved great fame, and belongs among the great artists of the century.

Vinnie Ream Hoxie was born in Madison, Wis. At an early age she showed such marked ability as a sculptor as to attract public attention, and her parents were induced to give her special training. She made striking pictures of many of the pub-

lic men of the day, among them President Lincoln, who gave her sittings only a few months before his assassination. This model was transferred to marble, and now stands in the Capitol at Washington. Spurgeon, Cardinal Antonelli, and Liszt each gave her sittings for likenesses. Her three marbles, "America," "The West," and "Miriam" which were exhibited in the Woman's Building at the Columbian Exposition, attracted great attention.

The painters of the century have surpassed in number and in ability, with a few rare exceptions, all antiquity. The following who have rarely been surpassed may be named: Benjamin West (1738-1820), C. W. Peale (1741-1827), John Trumbull (1756-1843), John Hoppner (1758-1810), Mrs. Kenyon Cox, J. B. C. Corot (1796-1875), J. H. Beard (1814), John Balantine (1815), J. L. David (1748-1825), W. C. T. Dobson (1817), Rosalie Bonheur (1822), A. Bierstadt (1825), John Constable (1776-1837), G. A. Bouguereau (1825), B. Foster (1825), John Faed (1826), T. Faed (1826), Holman Hunt (1827), T. V. Cole (1833-1898), A. Bartholdy (1834), Edouard Detaille (1847), E. Burne-Jones (1833), J. L. Gerome (1824), E. A. Abbey (1852), Geo. Inness (1825-1894), Eastman Johnson (1824), Chr. C. Ingham (1797-1863), Wilhelm Kaulbach (1805-1874), J. F. Kensett (1818-1872), J. L. E. Meissonier (1811-1891), J. F. Millet (1819-1875), E. H. Landseer (1802-1873), C. G. Stuart (1756-1828), J. M. W. Turner (1775-1851), F. Overbeck (1789-1869), E. J. Verbeckhoven (1798-1881), V. Verestschagin (1842), A. C. H. Vernet (1789-1863).

Besides there is a great multitude whose genius has shed luster on their art, such as Thomas Cole (1801-1848), De Neuville, E. Church (1826), John Comstock (1776-1837), J. F. Cropsey (1823), C. S. Eastlake (1793-1865), F. V. E. Delacroix (1799-1863), P. H. Delaroche (1797-1856), M. J. Fortuny (1838-1874), William Hart (1823), J. E. Hodgson (1831), J. A. D. Ingres (1780-1867), Emanuel Leutze (1816-1868), J. E. Millais (1829-1896), J. Northcote (1746-1831), John Opie (1761-1807), S. Prout (1783-1832), H. W. Weir (1824), C. Stanfield (1798-1867), D. Wilkie (1785-1841), L. Alma Tadema (1836), A. W. Callcott (1779-1844), William Blake (1757-1858), J. S. Copley (1737-1815), James Barry (1741-1806), J. H. L. DeHaas (1832-1880), B. R. Haydon (1786-1846), James M. Hart (1828), William Hilton (1786-1839), W. H. Hunt (1790-1864), J. B. Kensett (1818-1872), P. J. Hamerton (1834), D. Maclise (1811-1870), Bastien Lepage (1848-1884), John E. Millais (1829-1896), A. Nasmyth (1758-1840). Italian, G. Bossi (1777-1815), J. Israels (1824). The American, Benjamin West (1738-1820), R. Peale (1811-1835), F. E. Church (1826), H. Mokart (1840-1884), Thomas Moran (1837), E. Vedder (1836), George Inness (1825-1894), Thomas Cole (1801-1848), George Catlin (1796-1872), E. J. Niemann, (1813-1876), A. B. Durand (1796-1874), T. Sully (1783-1872), G. H. Smillie (1840), William Page (1811-1885). French, P. Chery (1759-1838),

Edmund Bristow (1787-1876), G. Doré (1833-1883), F. Gerard (1770-1837), E. L. G. Isabey (1804-1886), H. R. A. G. Maupassant (1850-1893), R. Menard (1827-1887), John Sargent (1856), Ary Scheffer (1795-1858). Dutch in Paris, F. O. C. Darley (1822-1888), Alexander Harrison, E. Vedder (1836), Thomas Hovenden, etc.

Sir John Gilbert, R. A. (1817-1897) exhibited his first picture in 1836. He was better known to the English-speaking public as an illustrator of books and periodicals than as a painter. Among his most important illustrations are those of an edition of Shakespeare, upon which he spent several years. In 1871 he was elected president of the Royal Society of painters in water colors, in whose galleries he has been a constant exhibitor. In 1893 he divided his collections among the art galleries of London, Manchester, Birmingham and Liverpool.

Michael Munkacsy (1846) was a carpenter before he became a painter. Among his famous paintings may be mentioned "Christ Before Pilate," "Christ on Calvary," "Milton Dictating Paradise Lost to His Daughter," and "The Last Moments of Mozart." He will never paint again, for the reason that he has lost his mind and is a hopeless victim of insanity.

Vasili Vasiljevitsch Verestchagin (1842) is certainly the greatest painter in Russia and one of the greatest in the world. In fact, the Swedish academy has decided that Verestchagin has done more for the good of man in art than any other living painter. He is a painter, a traveler, a writer, and a philanthropist. He has put upon canvas the hideousness of war. His pictures, once seen, haunt the memory ever after.

Guillaume Adolphe Bouguereau (1825) is rated as the greatest figure painter of the century.

Rosalie Bonheur (1822) is easily the greatest of modern animal painters.

Sir John Everett Millais (1829-1896).

James Abbott McNeil Whistler (1834) was born in this country, though his art life has chiefly been spent in Europe. He settled in London in 1863. He is a great artistic genius, whose works are in a style all his own.

The humorists with the pencil have for the first time become numerous and great during the present century, and the number seems to increase with almost geometrical progression. In fact, the daily press of all nations contains cartoons that a hundred years ago would have made fame and fortune for any artist, while the humorous papers display great genius in illustrations that retire abuses that would long resist sober argument. "Punch," "Puck," "Judge," "Bladderadatsch," the illustrations in the literary weeklies and monthlies have created a new literature, and have not only made the world laugh, but have contributed to human progress. Eminent in this field are George Cruikshank (1792-1878), John Leech (1817-1864), George Du

Maurier (1834-1896), Thomas Nast (1840), and many others.

The Pre-Raphaelites are those belonging to an association founded in 1848 by William Holman Hunt, John Everett Millais, and Dante Gabriel Rossetti (1828-1882), the last of whom suggested the title "Brotherhood." They were some time afterward joined by Thomas Woolner (sculptor), James Collinson (died 1881), Frederick George Stevens (art critic), and William Michael Rossetti. With few exceptions, the whole of the English-speaking press attacked them as Mr. Ruskin thought, unfairly, and he defended them in a letter to the London "Times" (May 5, 1854). "The Pre-Raphaelites imitate no pictures; they paint from nature only. But they have opposed themselves as a body to the kind of teaching . . . which only began after Raphael's time, and they have opposed themselves as sternly to the entire feeling of the Renaissance schools, a feeling compounded of indolence, infidelity, sensuality, and shallow pride. Therefore they have called themselves Pre-Raphaelites. (Ruskin "Pre-Raphaelitism" [ed. 1852], p. 25.)

J. James Tissot (1837), at the age of fifty, devoted ten years to study in Palestine, and to a realistic pictorial life of Christ. Five hundred splendid paintings, reproduced in engravings, are monuments of his genius.

ALFRED TENNYSON.

[Born 1809. Died 1892.]

One who was with him the night before he first took his seat in the House of Lords, said:

"I witnessed the grand and simple dignity with which he advanced to sign his name on the list of peers. Never was a man less elated with the pride which more vulgar natures might have displayed even against their will. A noble name could add but little luster to a character so natural, so manly, and so noble as that of this great teacher of his age."

CHAPTER XXXVI.

ARCHITECTURE.

WONDERFUL IMPROVEMENTS IN DOMESTIC ARCHITECTURE—IRON AND STEEL IN BUILDINGS—THE BALLOON FRAME—THE FLOAT FOUNDATION—PRIMITIVE DWELLINGS IN 1800.

LESS progress seems to have been made in architecture than in any other department of art. No new style has originated—the great churches and public buildings are copies of ancient edifices—but the various styles have been adapted to religious, civil, and domestic uses, so that there was never so much beauty and convenience as now. This is especially true of human homes and of business buildings. Not only the palaces and mansions of the rich, but the dwellings of the middle classes and the cottages of the poor are more convenient and beautiful than in any previous epoch of the world's history. Comfort and luxury characterize human habitations as never before. The mechanic or farmer who once lived on stone or earthen floors, and later on boards strewn with sand, now is poor indeed if he has no carpet on his best room floor, and the stone hovel he once occupied is now a picturesque cottage. Everywhere, in village and country, houses are homes, and not hovels or shanties, except with the most shiftless and improvident.

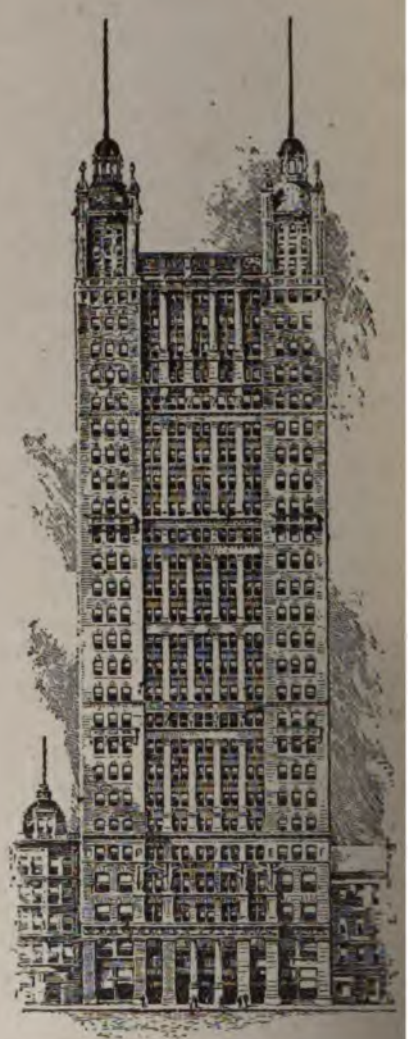
The introduction of iron and steel has rendered buildings loftier and safer than ever before. Steel frames riveted securely together, with brick or stone veneering, give stronger buildings than were once possible. In the great cities "sky-scrapers" as high as twenty-two stories are considered perfectly secure. Ornamental edifices of steel and glass, such as the Crystal Palace in London, and the graceful buildings in parks, are new architectural features. (See "Iron.")

The "balloon frame" in house-building is a Chicago invention. The exact date and the name of the inventor are unknown. But the lightness, strength, and economy over the cumbersome and clumsy frames it superseded caused it at once to be adopted everywhere.

The Float Foundation. In 1847 Alfred Guthrie placed timbers on the ground horizontally to support the posts of the Canal Pumping Works, Chicago. He used 12x12 oak timbers, side by side, covered with plank, on which the walls were erected. Later the Montauk Block on Monroe street, had a similar foundation. Subsequently steel railroad rails were used, and these are now generally employed under large buildings. The weight resting on each column is so distributed as to render settling impossible.

In the beginning of the century, says D. J. Powers: "Houses were mainly of wood, and in building them heavy timber frames were considered indispensable, jointed and pinned together, stout enough for a ship, the timber all being hewed and counterhewed by hand. And, when the structure was framed and ready, the next step was what was called a 'raising;' consisting of a gathering of enough of the neighbors to raise the broad side of the frame, called 'bents,' up bodily with pike-poles and by hand, two stout and trusty fellows holding the feet of the posts with hand spikes to prevent them slipping, and so as to guide the tenons on the posts into the mortises of the sills. When the bents were all set up and temporarily secured in upright position, the plates were put on, then the ridge-pole, the rafters, and the frame was up; not, always, however, without accident. Sometimes a bent or broadside would get away and come crashing down among the crowd of lifters; when it was good luck if no one was killed or hurt. This danger was often considerably increased by the free flow of rum or whisk which, by the way, was requisite all raisings, and any one to have had raising without it in those early day would have been considered a singu larity, if nothing worse, and he wou not have been very likely to ha got his building up.

A BUSINESS BLOCK IN 1820.



MODERN SKY SCRAPER.

A SKY-SCRAPER.

"The introduction of iron and steel has rendered buildings loftier than ever before."

THE MODERN TELESCOPE.

"The Lick telescope is one of the largest instruments in the world."

"How differently a house frame is constructed and put up nowadays. Instead of going to the forests for big timbers for anything but the sills, and those are usually sawed, all the structure above them is composed of scantling and joists, of comparatively small dimensions, put up 'balloon' fashion, as this style of building was christened in derision when it first appeared, some fifty years ago. Such a frame is easily and rapidly put up by two or three common workmen, requiring less skill than hewing and counter-hewing, and mortising and tenoning. Of course, all wise people knew perfectly well that such frames would never, never stand, when they first appeared. But in spite of the prophecy of the wise men they were found to be stiff and strong, if skillfully put together, after the outside and inside finishing was properly applied. Such frames, for ordinary light structures, such as dwelling houses, were soon found to be all right, and quickly superseded the old-style frames, and with them the raising and whisky jollification accompaniment disappeared. The finishing up of the house after the frame was up was also a very different affair at the two periods; under the old style the joiner came with his planes, his ploughs and moulding and beading tools, his chalk line and rip saw, and attacked the pile of undressed lumber with jack plane and saw, and worked and sawed away as best he could, and after an awful amount of good hard work, and many, many weeks he would complete the job, making panels, doors and sash by hand, and shutters if they were deemed necessary; usually they were of solid panels instead of the reversible slats of modern times. Now how is all this done?

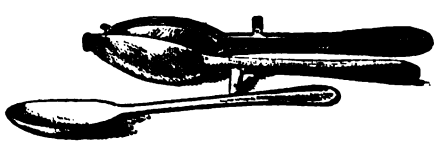
"The inventor has gotten up machinery for preparing every part of the work. The lumber is all dressed at the mill into every form and shape desired. Every moulding, pilaster and casing is dressed exactly as required. And frame, door and sash are made complete at the factory, so that the joiner has nothing to do but to set up the work and secure it in place. Thus the labor of finishing up a house is reduced to a very simple and expeditious undertaking. Planing and moulding machines have only been known and in use a little over fifty years, and have been greatly amplified and perfected within the last twenty-five years, until at the present a fully equipped wood-working factory for preparing lumber for house furnishing shows an interesting display of human ingenuity and a wonderful illustration of the capability of labor-saving machinery as compared with the old and laborious style of hand work. A good planing mill will prepare more material in a day in far better order than several workmen could do in three months. Woodruff and Daniels, of New England, were the pioneers in this line of invention between the years 1830 and 1840, and hundreds of other ingenious men have amplified and improved upon these early inventions. The house of the early half of the

century was as unlike the houses of the present, as were the ways of building it—a square two-story structure with small windows of small glass, and a central front en-

A WARMING PAN.

trance and hall with rooms on either side. Upon one side was what was known as the 'square room,' corresponding with the modern parlor, and upon the other the family sitting room. A large chimney was centrally located with fire-places opening into each principal room in each story, for heating purposes, while in the kitchen was a big and deep fire-place with crane and pot hooks for the family cooking, and beside it a big brick oven and ash hole underneath. Such a thing as a cook or heating stove was still a stranger, a novelty never met with in ordinary houses, and hardly existing anywhere during the earlier quarter of the century, although they began to appear in various rude forms during the next quarter.

"The good housewife of those early days did her cooking before the kitchen fire with bake kettles



PEWTER SPOON AND MOULD.

and long-handled frying pans, the handles being at least four feet long. Then the fire shovel had a handle of equal length to render it suitable for cleaning out the oven, and also to reach the live coals under the back log when they were needed for frying or baking."

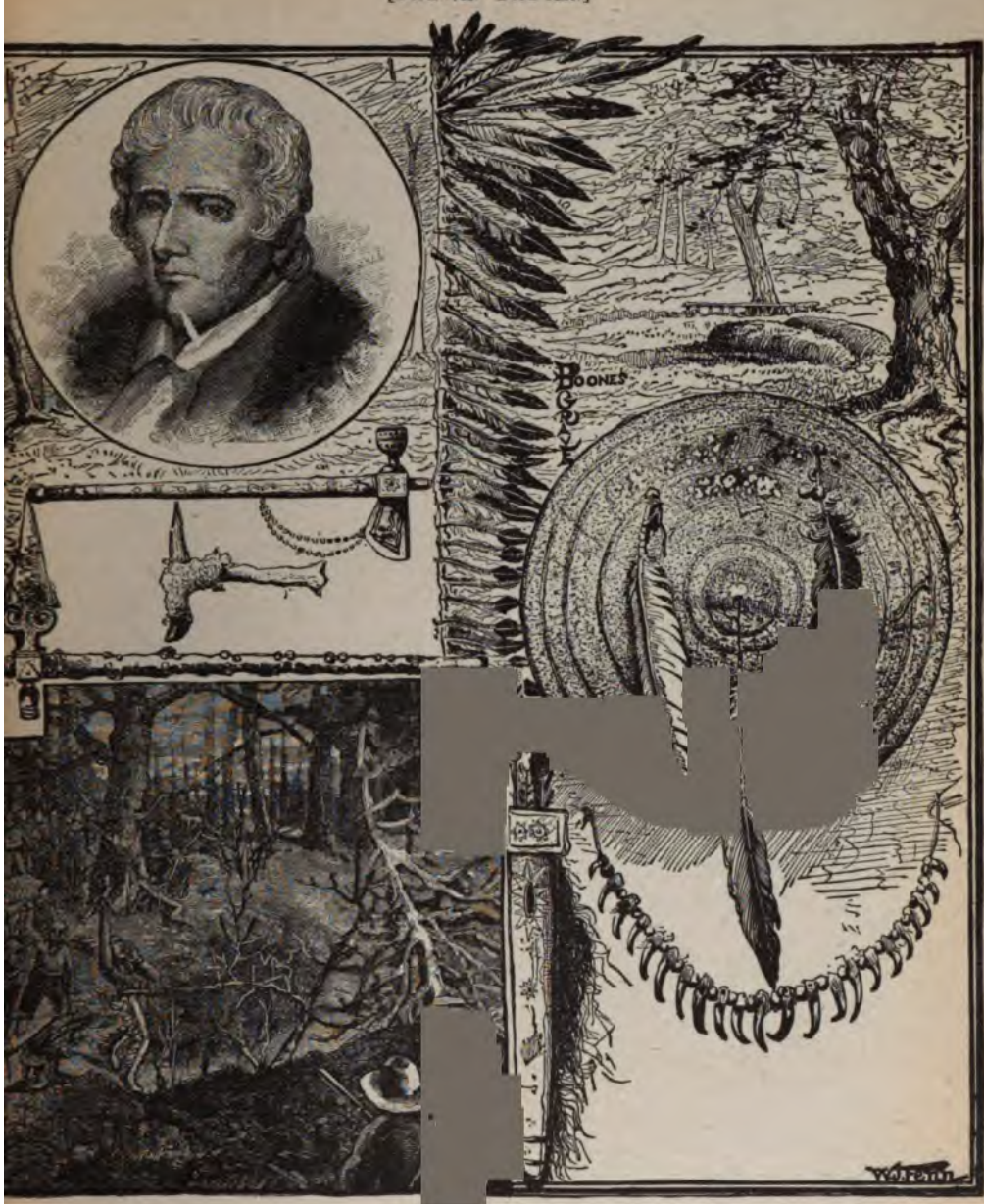
In most houses, at the century's beginning, the kitchen was the family room—large, with floor sanded, beams and rafters in sight, and seats on each side of the immense fire-place, where the children sat and saw the "sparks fly upwards." A carpet on any floor was as rare as a pipe organ in any modern home. Pewter mugs and porringers were

OLD-FASHIONED WINDMILL.

the common drinking vessels almost universally. The daily evening meal of children was bread and hasty pudding and milk, in the pewter porringer, which was a shallow, flat cup, with an open-work handle. Spoons, with rare exception, were of the same material, and were recast in moulds of wood or iron when worn out. Forks were seldom used, and were two-tined. Door bells were unknown. Front doors were ornamented with iron or brass knockers, often most elaborate.

DANIEL BOONE.

[Born 1735. Died 1820.]



This greatest of American pioneers, who, with his rifle, his axe, and his native strength of character and purpose, reclaimed so vast a portion of the national domain to civilization, was a native of Pennsylvania. When he was only eighteen his parents removed into North Carolina, where young Boone readily fell in with the wild and free life, half savage, half civilized, of a hunter, explorer, and scout,—a character and a career peculiar to American civilization and distinguishing it by a unique type.

CHAPTER XXXVII.

GENERAL PROGRESS.

BARBAROUS MANNERS AND CUSTOMS IN 1800—GREAT PROGRESS IN REFINEMENT AND CULTURE, AND IN COMMON AND ALL DOMESTIC LIFE—PROGRESS OF THE COMMON PEOPLE.

AT the beginning of the century, says Professor Kennedy: "A general coarseness of manners prevailed. Profane swearing was the constant practice of gentlemen. They swore at each other because an oath added emphasis to their assertions. They swore at inferiors because their commands would not otherwise receive prompt obedience. The chaplain cursed the sailors because it made them listen more attentively to his admonitions. Ladies swore, orally and in their letters. Lord Braxfield offered to a lady at whom he swore, because she played badly at whist, the sufficient apology that he had mistaken her for his wife. Henry Erskine (1746-1817), the model of a forensic orator, swore at the bar. Lord Edward Thurlow (1732-1806) swore upon the bench. The king swore incessantly. When his majesty desired to express approval of the weather, of a handsome horse, of a dinner which he had enjoyed, this 'first gentleman in Europe' supported his royal assevera-

HOME COMFORTS A CENTURY AGO.

tion by a profane oath. Society clothed itself with cursing as with a garment. Books of the grossest indecency were exhibited for sale side by side with Bibles and prayer-books. Indecent songs were sold without restraint on the streets of London, and sung at social gatherings by the wives of respectable tradesmen without sense of impropriety." Language and manners that would not now be tolerated even in rude and uncultivated homes were then the rule among the most cultured and best people, and words that have long since been banished to the dictionary were in common use. In everything that relates to social, domestic, and industrial matters the people of the end of this century are further from those of its beginning, than were they from those who lived in the days of William the Conqueror. In 1800 all travel was as it had been for hundreds of years. The mails, the news from a distance, heating and lighting, drainage and ventilation, medicine, food and its preparation, in fact, the whole of life was as it had been for centuries. Place the man of thirty of to-day back in 1800, and he would be as much lost and out of gear with his surroundings as would the man of 1800 have been had he been transported to a savage community.

During the century the churches have made wonderful strides in membership, wealth, and influence in the civic and social life. Thousands of new churches have been built and dedicated to the dissemination of a gospel which first taught the principles of a true democracy, and laid the foundations of law and order. All the churches, Protestant and Catholic, are closer together until the lines of denominational differentiation are almost obliterated. Indeed the spirit of religious tolerance was never so widespread as it is to-day. The churches have not only increased in the number of active communicants, but Christianity has grown in the popular respect and esteem. The fact that the essential principles of Christianity, as they were taught by Christ, are the foundations of all right living, and the corner stone of society and social order, was never so generally recognized by all sorts and conditions of men as at present. There has been a marked obscuration of creed and dogma, and a notable advance toward the essentials of right conduct that were proclaimed by the Master. And not only so, but the adhesion of the people to the Christian religion is far greater at the end than it was at the beginning of the century.

Dr. O. W. Holmes describes the changes in religion that have occurred since his youth. He says: "Since that time a remarkable change has taken place in the attitude of men toward each other in all that relates to spiritual matters, especially in this respect: that Protestantism is more respectful in its treatment of Romanism, orthodoxy in its treatment of heterodoxy, supernaturalism in its treatment of naturalism, Christianity in its handling of humanity. The limitations of men are better realized, the impossibility of their thinking alike more fully recognized, the virtue of humility

found to include many things which have often been considered outside its province, among others the conviction of the infallibility of our own special convictions in matters of belief, which appeal differently to different minds."

All the developments of the century point onward and upward, none are retrogressive. The lesson of the Nineteenth Century is to-day better than yesterday, and to-morrow will be better than to-day. The love of mankind is taught more impressively than ever, both by religion and by science. There is more altruism, thought for others, than ever before. The benefactions of the rich for education, in various forms and directions, are often phenomenal. And benevolences for the aid of suffering humanity are innumerable. These are also personal as well as financial. Much effort is for the prevention rather than the cure of misery. The defective classes are more successfully cared for; the prisoner's manhood more faithfully recognized and respected, and the world is learning better and better how to exemplify the spirit of Jesus the Christ.

Those who are living in these grand days may congratulate themselves on standing in the evening twilight of the Nineteenth Century, and in the dawning of the twentieth. Had we been able to choose our lease of life on earth could we have chosen a better date? Wise students have declared that the advance which the world has made, industrially, within the last one hundred and fifty years, is greater than that of the previous two thousand. And when we remember how many very important scientific discoveries and labor-saving inventions have been given to the world since 1870, it is perhaps not too much to say that the industrial advance which the world has made within the last twenty or thirty years, is equal to the previous one hundred and fifty.

Incidentally it may be remarked that Japan has made wonderful strides within a few years, perhaps greater than any other nation. In 1853 Commodore Perry opened Japan to the commerce of the world, and since then the island kingdom has made unparalleled progress.

Professor Robert Mackenzie, in his excellent work, "The Nineteenth Century, a History," says: "The nineteenth century has witnessed progress rapid beyond all precedent, for it has witnessed the overthrow of the barriers which prevented progress. Never since the stream of human development received into its sluggish currents the mighty impulse communicated by the Christian religion has the condition of man experienced ameliorations so vast. Despotism thwarts and frustrates the forces by which Providence has provided for the progress of man; liberty secures for these forces their natural scope and exercise. The nineteenth century has witnessed the fall of despotism and the establishment of liberty in the most influential nations of the world. It has vindicated for all succeeding ages the right of man to his own unimpeded development. It has not seen the redressing of all

wrongs: nor indeed is that to be hoped for, because in the ever-shifting conditions of man's life the right of one century becomes frequently the wrong of the next. But it has seen all that the most ardent reformers can desire—the removal of artificial obstacles placed in the path of human progress by the selfishness and ignorance of the strong. The growth of man's well-being, rescued from the mischievous tampering of self-willed princes, is left now to the beneficent regulation of great providential laws."

The fifteenth century was remarkable for the revival of Art and Literature and Discovery; the sixteenth for the Reformation; the seventeenth for the Rise of Liberty; the eighteenth for the establishment of Free Government; the nineteenth for Invention and General Progress.

Beyond all other centuries, the nineteenth marks the progress of the common people. Not only do discoveries and inventions outnumber those of all preceding centuries, but they contribute to the welfare of the masses. The people are profiting by all the great improvements of the times.

The progress in manners, even among the so-called refined, up to the middle of the century, is thus described, in 1856, by Thackeray: "I can see old gentlemen among us, of perfect good breeding, of quiet lives, with venerable gray heads, fondling their grandchildren; and look at them, and wonder at what they were once. That gentleman of the grand old school, when he was in the Tenth Hussars, and dined at the Prince's table, would fall under it night after night. Night after night that gentleman sat at Brookes' or Raggett's over the dice. If, in the petulance of play or of drink, that gentleman spoke a sharp word to his neighbor, he and the other would infallibly go out and try to shoot each other the next morning. That gentleman would drive his friend Richmond, the black boxer, down to Moussey, hold his coat, and shout and swear, and hurrah with delight, whilst the black man was beating Dutch Sam, the Jew. That gentleman would take a manly pleasure in pulling his own coat off and thrashing a bargeman in a street row. That gentleman has been in a watchhouse. That gentleman, so exquisitely polite with ladies in a drawing-room, so loftily courteous, if he talked now as he used to in his youth, would swear so as to make your hair stand on end." Since then the progress has continued along the same lines.

THOMAS HOOD.

[Born 1799. Died 1845.]

he tombstone of Hood, and in the books of the Recording Angel, are inscribed the words, "He Song of the Shirt." That city of the dead hides in its underground mansions many mute lips ife spoke eloquently, many right hands that at the bidding of the inspired brain wrote down ver which, though the hands are coffin-dust and the pens they wielded have long since rusted housands of readers still laugh or weep. No laughter had ever a heartier ring, no tears came re truly from the heart, than the tears and laughter the world owes to Thomas Hood.

CHAPTER XXXVIII.

EUROPEAN PROGRESS.

EXPANSION AND DEVELOPMENT OF ENGLAND — FRANCE—GERMANY—ITALY—RUSSIA — GROWTH IN CIVILIZATION — SUFFRAGE — EDUCATION — GREAT STATESMEN—GLADSTONE—COBDEN—BISMARCK—BROUGHAM.

PREVIOUS to the end of the first half of the century continental Europe was controlled by tyrants, and the rights of the people were ignored. With the exception of Russia, the eastern continent—a population of 180,000,000—has become self-governing, and constitutional liberty prevails,—a degree of popular progress that Europe never before achieved in ten centuries has been accomplished within a hundred years.

The effect of the deeds of Napoleon on the liberties and progress of Europe was not all evil. He destroyed the petty states of Italy and Germany, and prepared the way for that unity which now is seen in those two great nations, and he aroused such a hatred of oppression as resulted in an immense accession of popular liberty. When he began his career Germany consisted of more than three hundred independent powers. Italy was a group of petty monarchies. Switzerland was a federation of twenty-two republics. The century has witnessed the unification of the little powers into great nations, and popular liberty has made great strides.

The French revolution rendered forever impossible the continuance of the despotism which had heretofore governed Europe. Napoleon himself one of the most extreme of despots—sowed revolutionary principles broadcast over Europe. His judicial code taught the equality of man before the law. His overthrow of multitudinous princes inculcated a lower estimate than had hitherto prevailed, of the sanctity of crowned heads. His consolidation of the petty German states awakened the desire for a united Germany, and paved the way for its accomplishment. His administration of Italy taught the excellence of unity and self-government—lessons which the people effectively learned and never forgot. He gave constitutional government for a time to Naples, Westphalia, and Spain. He weakened the temporal power of the pope; he dealt fatal blows at the immunities of the old feudal nobility. His rude assault shook to its foundation the whole fabric of privilege and unjust preference of one class over its fellows, and led the lower orders of the people to entertain new ideas regarding their own rights. Never before had influences so powerful been brought so widely into operation over vast multitudes of men. The results were quickly apparent. When Na-

poleon fell the desire for self-government had silently overspread Europe. And the anxiety which distressed monarchs evinced to please their subjects, and thus gain their help against the arch-oppressor, began to disclose to the people the secret of their own strength. "The influence which Napoleon exerted upon the course of human affairs is without parallel in history. Never before had any man inflicted upon his fellows miseries so appalling; never before did one man's hand scatter seeds destined to produce a harvest of political change so vast and so beneficent. Assuming, as he did, the control of a people who had flung aside their government, it was a necessity of his position, not merely to defer to democratic influences at home, but also, as opportunity offered, to extend their dominion among foreign states. It was he who roused Italy from her sleep of centuries, and led her toward that free and united national life which she at length enjoys. It was he who, by destroying the innumerable petty states of Germany, inspired that dream of unity which it has required more than half a century to fulfill. He was the dreaded apostle of democracy. When Washington died, Napoleon invited his soldiers to mourn the man who had fought for liberty and equality. It was his intention, had he effected a landing in England, to proclaim the sovereignty of the people. By the institutions which he created, by the doctrine which he was obliged to profess, by the very violence of which he was guilty, he communicated to the human mind an impulse which it can never lose. And even when he became utterly and shamelessly despotic—when he laid intolerable burdens upon the people, when he squandered their lives, when he trampled on the lives of nations—even then his influence was favorable to popular rights. For the hatred which his despotism evoked, and the vast combination of forces which it rendered necessary, united the people, and taught them to know their own strength. For a time the kings who had conquered him were irresistible. But his career had created and strengthened impulses in presence of which kings are powerless. Napoleon, himself one of the most selfish and remorseless of despots, made the overthrow of despotism and the final triumph of liberal principles inevitable in all the European countries."—Mackenzie, "The Nineteenth Century."

FRANCE.—At the beginning of the century France, with its 25,000,000 inhabitants, was a camp. Centuries of oppression had reduced the people to the last verge of endurance, and the vices and crimes of their oppressors had so outraged them, that they hailed as their deliverer the great military genius who was to concentrate in his scepter the vices of many tyrants. The reaction from the abuses of centuries was the French revolution, which, despite its horrors, presaged a better day. Wordsworth saw its significance:

"Bliss was it in that dawn to be alive,
But to be young was very heaven! O times
In which the meagre, stale, forbidding ways
Of custom, law, and statute, took at once
The attraction of a country in romance!
Not favored spots alone, but the whole earth
The beauty wore of promise."

Napoleon Bonaparte for a while perverted the glorious French people from their purpose, and prolonged and intensified their woes. Had he been of the spirit of Washington, the history of France might have paralleled that of the United States. Instead, a vast debt was incurred by a foreign army of 1,000,000 men; foreign trade was destroyed, business was dead, and the nation was at its lowest ebb.

The wonderful recuperative power of the French people soon brought the dawn of prosperity, but it was destined to be obscured by the horrors of another revolution.

After the great revolution and Napoleon, and the humiliation of Waterloo, came the reign of the Bourbons, from 1815 to 1848. Then followed the Second Republic, the election of Louis Napoleon in 1848, the *coup d'etat* and the plebiscite, and in 1870 the Franco-Prussian war, the end of the empire, the commune and the new republic. Through all these convulsions the French people manifested a recuperative ability unsurpassed by any nation. Among the great names of the period are Louis Blanc (1811-1882), La Fayette (1757-1834), Alphonse de Lamartine (1792-1869), C. M. Tallerand (1754-1838), General N. A. T. Changarnier (1793-1877), L. E. Cavaignac (1802-1857), Leon Gambetta (1838-1882), Jules Grevy (1813-1891), C. L. L. J. Lamoriciere (1806-1865), F. C. Canrobert (1809), B. C. Favre (1809-1880), Jules Ferry (1832), MacMahon (1806), Napoleon III. (1807-1873), Adolph Thiers (1793-1877), and greatest of all, Napoleon I (1768-1821).

But France issued from all its struggles republican, and the people are now comparatively free. The constitution is democratic. There are two legislative bodies—the chamber of deputies and the senate. Every citizen twenty-one years of age is entitled to vote in the election. Every citizen of twenty-five may be a deputy; of forty, may be a senator. The head of the government is the president, elected for seven years by the senate and chamber of deputies in national assembly. The president appoints his ministers, who are responsible to the chambers for their policy. The nation is moving steadily along the lines of progress.

ITALY.—While Italy has been progressing and its many provinces and princedoms have become one in a United Italy, "Rome," as a temporal power, has sought in vain to resist and arrest the march of progress. Opposing the schemes of Napoleon, the French tyrant wrested the temporal power from his Holiness, in 1798, and reaffirmed his policy to his successor, Pius VII. in 1804, and in 1809 annexed the Roman states to the French empire. But on Napoleon's fall the pope's possessions were restored to him, in 1814, by the congress of Vienna.

The accession of Pius IX. in 1846 seemed to presage a progressive administration of papal affairs, but his encyclical letter in 1864 was an assault on all civil and political progress and an indictment of eighteen centuries of Christian influence, and the Ecumenical Council of 1869 and the edict of papal infallibility placed the papacy before the world in opposition to the march of progress.

At this juncture, 1870, France and Prussia were in conflict; the Italian government sent an army to Rome; Victor Emanuel entered the holy city at the head of the Italian troops; Prussia withdrew her support from the pope, and in 1872 expelled the Jesuits from Germany. In 1875 Prussia, Italy, France and Austria declared marriage a civil contract, and the temporal sovereignty was forever gone from Pio Nono. So that though the papacy has always hated and yet hates the world's progress, its deprivation of temporal power may be recorded as a distinct step of progress, accomplished wholly in opposition to every principle of the papacy, but in obedience to the irresistible spirit of the age. The papacy is an anachronism in the Nineteenth Century, and yet its present status illustrates the progress of events.

RUSSIA.—Even autocratic Russia is feeling the spirit of the age. Czar Nicholas has abolished the custom of exiling political offenders to Siberia, and instead has substituted confinement in the large central prisons of Russia for the graver offences that may be committed against the state. This marks a progressive step of vast importance, as it indicates that Russia has at last passed the stage, in her political and industrial developments, when the old time barbarities which are associated with the very word Siberia are possible. The extent to which the system of political exile to Siberia was carried out may be judged from the fact that in a single year 14,000 men and 1,000 women were condemned to exile and its untold tortures and barbarities.

Previous to a few years ago, the administration of law had been fearfully corrupt, but in 1862 most valuable reforms were inaugurated, so that comparative justice is executed by legal tribunals, and a degree of freedom of political action is enjoyed, far in advance of anything known in Russia before.

"In point of extent, Russia is the largest dominion in the world. She has nearly quadrupled her possessions in the century. The waters of the Arctic sea wash her northern shores; on the south she looks out upon the Mediterranean; the Pacific bounds her on the east; the Atlantic may almost be said to bound her on the west. The czar gives law to one-seventh part of the earth's surface. From his palace in St. Petersburg he governs a people seven thousand miles away on the remotest coasts of Asia. His subjects number 102,000,000. And though the condition of the empire is yet far below that of other European powers, yet it is on the road of progress. She has subjugated innumerable wandering tribes, to whom law and industry were unknown. She has not be-

stowed upon them a high civilization—for they were not able to receive it, and she herself does not possess it; but to the extent of their capacity she is teaching them to be orderly and industrious. Wherever her arms have been carried, slavery has been abolished. Her teaching is always stern, often cruel. It is not in her nature to impart, nor in that of her subjects to receive, any other. Her influence has, however, beyond doubt, been beneficial to those who have been brought under her sway. It may be said that Russia has made greater progress during the Nineteenth Century than in all the previous years of her history. The proposition of the Russian czar, in 1898, for universal European disarmament, touches the high water mark of progress.

TURKEY.—Of the "unspeakable Turk" there is little of hopefulness to record. His religion forbids progress. Education, art, science, medicine, surgery, are discouraged by the Koran. The government is an organized robbery. The only hope for mankind is the prospect of the annihilation of the Ottoman empire—a prospect that seems far from discouraging, for its territory has been constantly abridged, and its population decreased, so that the extinction of the race, at least in Europe, is one of the hopeful indications of the future. And yet five new countries have been extracted from Turkey.

GERMANY.—At the end of the eighteenth century, there was no Germany. Prussia, the principal German state, during the Napoleonic wars, was despoiled of much of her territory, and was badly crippled. From the fall of Napoleon a growing sentiment among the German peoples resulted, in 1871, in the German Empire. A steady progress characterizes the German nation. A common school education is universal. Suffrage, of a kind, is nearly universal. Four million eight hundred thousand children, or nearly one in every six of the population, attend the elementary schools. A small fee is charged,—one penny per week in the country, and threepence per week in town. The balance is contributed by a local tax. A slow progression characterizes the German nation—almost entirely the work of the present century. Its roll of great men has been made up in the present century—Goethe, Von Moltke, Bismarck, Humboldt, Kant, are of the first rank in intellect, while philosophers, theologians, scientists, and distinguished names in every department of thought have equaled in number and ability those of any nation.

SPAIN.—Buckle, in his "History of Civilization," makes this statement: "The Spaniards are remarkable for their inertness. While the human intellect has been making prodigious and unheard-of strides, while the world is ringing with the noise of intellectual achievements, Spain sleeps on untroubled, unheeding, impassive, receiving no impression upon it. There she lies at the farther extremity of the continent, a huge and torpid mass, the sole representative now remaining of

the feelings and knowledge of the middle ages. And what is the worst symptom of all, she is satisfied with her own condition. Though she is the most backward country in Europe, she believes herself to be the foremost. She is proud of everything of which she ought to be ashamed." Her dominion in the western continent has been entirely removed.

AUSTRIA.—During the European struggles for liberty in 1848, and after Hungary had been crushed, Austria slowly crystallized into its present status. Progress has been less marked than in some of the other European nations. Francis Joseph became emperor in December, 1848, the year of revolutionary furor. The germ of all future political growth may be found in this conflict. In 1852 the emperor abolished the constitution. In 1855 he signed a concordat with the pope, which increased the powers of the clergy, and committed the education of the people to their care. But all this time the popular discontent was growing. By the war of 1866, Austria lost to Prussia on the north and to Italy on the south. She was compelled to relinquish Venetia, and her reign in Italy ended. She was deposed from the leadership of the German states. Chastened by the foreigners, the emperor again made concessions at home. He promised a responsible ministry and municipal self-government to Hungary, and introduced broad measures of reform for the empire at large. The concordat with Rome was suspended, and in 1873 the election of members of the reichsrath was transferred from the provincial diets to the electors direct. The old doctrines were now overthrown for good, and in the time that has elapsed since, the people of Austria and the associated governments have strengthened their gains. There has been much friction between Germans, Slavs and Magyars, which is still fruitful of trouble, but there is no question that the fifty years just closed have witnessed wonderful advances in civil liberty and self-government.

Norway, Sweden and Denmark are steadily growing in all the better elements of modern civilization. Belgium has become independent of Holland.

REFORM IN ENGLAND.—In the early part of the century there were many "rotten boroughs" in England, where a few powerful persons elected a largely disproportioned number of members of parliament. "The reform act of 1832 disfranchised fifty-six rotten boroughs, with less than 2,000 inhabitants each, and returning 111 members; thirty boroughs with less than 4,000 inhabitants, and two above that number, lost each a member. and thus 143 seats were obtained for distribution. Forty-three new boroughs were created, twenty-two of which received two members each, and twenty-one one member each. The county members for England and Wales were increased from ninety-five to 159, twenty-six of the large counties being divided, and a third member given to seven

HEROES OF WATERLOO.

"Wellington and Waterloo are names that suggest the turning point in European progress."

THE SURRENDER AT SEDAN.

important county constituencies. Scotch and Irish acts followed; the Scotch representation, fixed by the act of union at forty-five, was raised to fifty-three (thirty of them given to counties and twenty-three to cities and boroughs), and the Irish members, fixed by the act of union at 100, were increased to 105. The reform act of 1867 disfranchised eleven small English boroughs, took a member from thirty-five more, and two from Scotch counties, which, with four seats obtained from boroughs disfranchised for corruption, gave fifty-two seats for redistribution. Five of these were given to as many large English and Scotch boroughs on the three-cornered system, and three to universities, the others to old or new county or borough divisions. Seven members were added to Scotland. There was no distribution in Ireland. In the third successful effort for parliamentary reform, that of 1884-85, the franchise and redistribution of seats constituted two distinct acts. The franchise bill received the royal assent on December 6, 1884, and came into operation on January 1, 1885. It established household and lodger franchise in the counties, introduced a service-franchise, and made a uniform occupation franchise of £10 rent, both in counties and in boroughs, in place of the three formerly existing. It left untouched the forty-shilling freeholders of inheritance, and conferred votes on copyholders possessing land of greater value than £5 annually. By the redistribution act of 1885, eighty-one English, two Scotch, and twenty-one Irish boroughs were totally disfranchised; thirty-six English and three Irish boroughs each lost a member, as did two English counties; the city of London was reduced from four to two; six seats were obtained from places disfranchised for corruption, and the members of the House of Commons were increased by twelve. The seats thus obtained for redistribution were 180. The great feature of the scheme which followed (agreed to, after a conference between the two great political parties), was the separation of populous boroughs and counties into divisions, each returning a single member. Only a few places hitherto with two members were left with the old arrangement. England has now (1894), 461 members, Wales thirty-four, Scotland seventy-two, and Ireland 103, the reduction from 105 occurring through the disfranchisement of Sligo and Cashel some years ago for corruption."—W. A. Holdsworth, The New Reform Act.

The reform act of 1867 and the acts of 1884 and 1885 increased the number of electors from 3,000,000 to 5,000,000, and widened the scope of their rights.

When the century began there was no system of government education in England. (See "Education.") The education of the poor was the work of private charity. More than forty per cent. of the British people could not write their names when the queen ascended the throne. The proportion in that condition has now been reduced to seven per cent.

There was a poor law, which obliged rate-payers to support paupers; and sometimes the poor-rate became so grievous that it swallowed up the profits of the farmer and made him poor. He had to pay, besides tithes and church-rates (the latter for keeping church property in order), window tax for every window, taxes on his horses, if above the size of ponies; taxes on his cart wheels, taxes on malt, taxes on silver plate, if he had any; taxes on hair powder, if he wore it; taxes on property, if he inherited it, and taxes on every bill he paid, for no receipt for any sum above £10 was legally valid, unless it were written upon stamped paper.

Sydney Smith's (1771-1845) celebrated denunciation of taxation at that period was no exaggeration: "We have," he says, "taxes upon every article that enters into the mouth, or covers the back, or is placed under the foot; taxes upon everything which it is pleasant to feel, smell, or taste; taxes on everything in the earth, or in the waters under the earth; on everything that comes from aboard, or that is grown at home; taxes on the raw material; taxes on every value that is added to it by the industry of man; taxes on the sauce which pampers man's appetite, and on the drug which restores him to health; on the ermine which covers the judge, and the rope that hangs the criminal; on the poor man's salt, and the rich man's spice; on the brass nails of the coffin, and the ribbons of the bride; on bed and board—couchant or levant—we must pay. The schoolboy whips his taxed top; the beardless youth manages a taxed horse, with a taxed bridle, on a taxed road; and the dying Englishman, pouring his medicine, which has paid seven per cent., into a spoon, which has paid fifteen per cent., flings himself back upon his chintz bed, which has paid twenty-two per cent., and expires in the arm of an apothecary who has paid a license of one hundred pounds for the privilege of presiding at his death-bed. His whole property is then taxed from two to twenty per cent. Besides the probate, large fees are demanded for burying him in the chancel; his virtues are handed down to posterity on taxed marble, and he is gathered to his fathers, to be taxed no more."

When the century began, Great Britain had made little progress since the reign of Queen Elizabeth. Macadamized roads, canal boats and stage coaches marked the limit of progress.

In the beginning of the century a mighty genius rose who was to effect a great improvement in the condition of the English people, William Cobbett (1762-1835), whose writings were read beside every cottage hearth in England, and exercised an authority immediate and powerful. He never ceased to urge that misgovernment was the source of all the misery which the people endured, and that parliamentary reform was its natural and its only cure. His words sank deep into the public heart.

Clubs to promote reform sprang up all over the country, and before the end of 1816 the demand even

for universal suffrage was loud and urgent, and, though it had the opposition of the Duke of Wellington, in 1832 the reform bill was passed, and a government of the people, for the people and by the people was established for all time. Says Robert Mackenzie, "The Nineteenth Century": "The reform bill of 1832 is undoubtedly, for the British people, the greatest political fact of the nineteenth century. It has been called by its enemies a revolution; and it was so. Two methods of government have been practiced among men. The oldest and the most widely prevalent has been government by an individual or a class, very naturally with a supreme regard to the interests of that individual or that class. The other, which is of later origin, and, until recently was confined for the most part to the Anglo-Saxon family, is government by the people themselves, and for their own interests. The reform bill marks for Great Britain the vast transition from the old method to the new. Inasmuch as self-government educates and ennobles, inasmuch as the government of another humiliates and debases, the revolution which raised the British to the rank of a self-governing people may well be ranked as one of the most beneficent in their history."

In the last century in England dissenters were by law forced to sustain the Episcopal church, or Church of England, which they abhorred, and their ministers were not allowed to perform marriage rites, nor could dissenters be buried in the parish burial ground, unless the Church of England burial service were read, nor could they be graduated at Oxford or Cambridge until the year 1871. A Jew or non-conformist Christian could not sit in Parliament. In 1858 this restriction was removed. In 1838 tithes were no longer compelled, and in 1868 compulsory church rates were abolished. Not until 1838 were dissenting clergymen allowed to perform marriages.

In Ireland the people were compelled to contribute to the support of the "standing order," whether they accepted their tenets or not. In 1800 a handful of Episcopalians possessed and enjoyed vast revenues belonging to the Catholics. The population of Ireland was eight-tenths Catholics, one-tenth Episcopal, and one-tenth "dissenters." In 1865 Mr. Gladstone began the work of dis-establishment, and in 1869 the task was accomplished, largely through the labors of this greatest of English statesmen.

The land laws were in inextricable confusion, the result of ignorance, custom, and oppression, and great improvements were made in the relations between landlord and tenant.

Home-rule is now the demand of Ireland, and though not yet wholly achieved, the condition of the people, social, industrial, civil, religious, is vastly improved during the last fifty years.

In 1829 the bill which gave equal franchise rights to Roman Catholics in Great Britain was passed. Prior to that time and since the revolution of the Reformation, a Roman Catho-

lic could not hold any government office or sit in the House of Commons. Roman Catholic peers were excluded from the cabinet and from the performance of any of the great functions of state. In 1829 the Catholic relief bill was pulled through by Wellington, with the assistance of Peel, and the reign of George IV. forever distinguished by one act of most impressive justice. Now Roman Catholics share equally with Protestants every important post in the state.

Among the statesmen who have pleaded the cause of Ireland are Michael Davitt (1846), John Dillon (1851), T. M. Healy (1855), C. S. Parnell, Daniel O'Connell (1775-1847).

In 1801 there were laws which forbade the Catholic to be a member of the House of Commons, to hold any important crown office, or a commission in the army, to be guardian to a Protestant, to hold any civic office, without the written consent of the lord-lieutenant, to be a gamekeeper, or to have arms in his possession for sale or otherwise, unless he should first renounce the doctrine of transubstantiation and the worship of the Virgin Mary, and receive the sacrament from the Church of England.

Ireland lay for many years utterly prostrate under this cruel domination, unable to express her discontent more articulately than by frequent assassinations or occasional insurrection. Many of the Catholic gentry and traders quitted the country in disgust. At one time five-sixths of the English infantry were employed in maintaining the uncertain tranquillity of this unhappy and vilely-governed country.

In 1800 parliamentary representation in Scotland had scarcely an existence; the Catholics were unemancipated; the test acts unrepealed; men were hung in chains for stealing a few shillings in a dwelling house; no counsel allowed to a prisoner accused of a capital offence; the horrors of the slave trade tolerated; the prevailing tendencies of the age, jobbery and corruption.

After having suffered the oppressions inflicted by Great Britain, Ireland in 1810, began an agitation for the repeal of the legislative union between Great Britain and Ireland, which was made on January 1, 1801. On April 27, 1834, the House of Commons, by a majority of 485, negatived a motion by Daniel O'Connell in favor of repeal. In 1840 the National Loyal Repeal association was constituted. Many large and excited meetings were held on the subject during 1843. On October 8 the government prevented a meeting, and in 1844 brought O'Connell and some other repeal leaders to trial. He was convicted on February 12, but the sentenced was reversed by the House of Lords on September 4. The agitation for repeal gradually subsided. An effort to revive it in 1860 was unsuccessful. In 1870 it reappeared under the name of Home Rule. A home rule party, composed of a section of the Irish representatives, had existed in the House of Commons, and at the general election in that year fought under

the new reform acts; it was largely reinforced, it now being about five-sixths of the Irish representation. In deference to this expression of Irish feeling, Mr. Gladstone, as the head of an administration which had been formed with special view to this question, brought forward a bill for establishing in Dublin a Parliament, with an executive government, for dealing with all affairs specially Irish. The measure was accepted by Parnell on behalf of the homerulers as a reasonable fulfillment of Irish demands, but it excited a great deal of opposition, not only from the conservatives, but also from an important section of the liberal party, and was defeated by a large majority, together with a bill for buying out the Irish landlords. Mr. Gladstone then (1886) appealed to the country, and the result being unfavorable, resigned, and was succeeded by the Marquis of Salisbury. Mr. Gladstone, on again becoming the head of the administration, brought forward another Irish home rule bill, which was likewise defeated. Mr. Gladstone again resigned (March, 1894), and was succeeded by the Earl of Rosebery.

Professor James Bryce, M. P., writes to the New York "Independent," concerning the progress of the last sixty years in Great Britain: "The number and magnitude of the changes in human knowledge, human thought, and human society which it has witnessed, are such that we seem to be living in quite a different world from that of 1837. Although the extension of knowledge and of power has been most marked in the sphere of the sciences of nature, it has been extraordinary in other departments also. The knowledge of prehistoric man, the sciences of comparative mythology and philology, of folklore, and of primitive institutions, are creations of the last sixty years; so is our knowledge of the early history of the ancient nations of the East. The whole surface of the earth and every tribe inhabiting it is now known. Very little remains to be done in the way of geographical explorations. There have been periods in history as remarkable for striking events. None, I think, has witnessed such profound changes in human opinion and beliefs, changes not confined to one country, but more or less operative over the whole world. The world has contracted. It is a small world now, and a whisper is heard all over it. This is, perhaps, the greatest of all the changes."

Colonel Saunderson, M. P., replies to the same question asked by the "Independent": "Scientific progress is, to my mind, the chief and most wonderful characteristic of Her Majesty's reign. Its two most remarkable triumphs—the discovery of the laws which govern force, taking the shape of electricity, magnetism, and heat and light; next, the strides made in the steam engine, which has revolutionized locomotion. Thus the peoples of the world are brought into close contact, and social conditions entirely changed."

And the Marquis of Dufferin thinks the greatest progress is in the same lines: "The development of

science in its application to objects of practical utility."

In 1870 compulsory education was enacted. Since then school attendance has increased 2,750,000. In 1837 there were only fifty-eight persons in every 100 who were able to sign their names to the marriage register; in 1876 the number had risen from fifty-eight to eighty-one, and is steadily growing.

The British form of government is democratic in everything but name, and in some respects answers even more readily to the public pulse than does the American. The English franchise includes all but vagrants, and the monarch of that country has far less actual power than the President of the United States. Great Britain has nearly quadrupled her domain in the Nineteenth Century.

Queen Victoria's golden jubilee in 1887, and her diamond, in 1897, celebrated a career of greater national progress, and marked a more wonderful progress of the world, than any other monarch's reign ever witnessed. Ascending the British throne in 1837, at the age of eighteen, she has reigned already (1899) sixty-two years. The moral atmosphere of her court has not only been purer than that of any of her contemporaries, but it has been infinitely better than that of any antecedent British court. The influence of one of the best of women, as well as one of the best of European sovereigns, has been a chief factor in rendering the British an example to all other courts.

Among the great names in British history may be mentioned George Canning (1770-1827), Henry Brougham (1779-1868), R. T. Castlereagh (1769-1822), William Pitt (1759-1806), R. B. B. Sheridan (1751-1816), Daniel O'Connell (1775-1847), Prince Albert Francis Augustus Charles Emanuel German (1819-1861), C. J. Fox (1749 1806), Richard Cobden (1804-1865), H. J. T. Palmerston (1784-1865), Cardinal Manning (1809), James Martineau (1805), General Charles James Napier (1782-1853), Admiral Charles John Napier (1786-1860), Lord Melbourne (1779-1848), Lord Beaconsfield (1805-1881), Robert Peel (1788-1850), Sir Colin Campbell (1792-1863), J. T. B. Cardigan (1797-1868), Lord Wellington (1769-1852), and greatest of all, William E. Gladstone (1809-1898).

Notwithstanding the injustice and iniquities that yet prevail, one has but to retrospect a moment to see the wide contrast between 1800 and 1900 in any country—especially in Europe or America. A writer in Chamber's "Journal" says of "One Hundred Years Ago in England": "England was at war with France. To furnish food for powder the recruiting sergeant was assisted by the press gang. In 1798 Nelson won the battle of the Nile and broke the ocean power of Napoleon. The land campaigns of Wellington had freed the peninsula. But the slave trade in our colonies flourished. The printing machine was a mere hand-press. There were no cabs or omnibuses. Steam locomotion belonged to thirty years after date. There was no voting by ballot. Pocket boroughs flourished; political

debauchery was rampant. There was no police force. Superstition reigned supreme; every village had its 'wise woman' and fortune teller. Duels were common; so were diabolical outrages at sea. Men were executed for high treason, forgery and horse-stealing. Hanging, drawing and quartering were the cherished punishments of the criminal code. The hemp crop was the most flourishing and fruitful of harvests. The gibbet-post cast its awful shadow over the land. Public executions were a popular outdoor entertainment provided by the state for the edification of the people. Suicides were buried without the offices of religion at the meeting of four cross roads, with a stake through their hearts. Women were openly flogged. There was a public brand for scolds. Whipping posts and stocks were prominent in every town and village. Women were placed in the pillory and pelted by the populace with rotten eggs, putrid vegetables and the like. Flogging was of frequent occurrence in the army; deserters were incontinently shot; seamen were summarily hanged at the yardarm for mutiny. Even penny news rooms had their persecutions and martyrs. On the 6th of September, 1798, six informations were heard before the magistrate at Bow street, and laid by the stamp office against a Mr. Williams for suffering, in his room in Old Round court, sundry persons to read the Daily Advertiser and other newspapers for the consideration of one penny each. The offense being held to be clearly made out, the infamous Williams was convicted in the penalty of £5 on each information."

Nor have the manners of the people improved less than their machinery. "The ordinary manners of the society at the court (of George IV., and William IV.) had a full flavor, to put it in the softest way, such as a decent tap-room would hardly exhibit in a time like the present."—McCarthy's "History of Our Own Times." (See "General Progress.")

The expansion of the principle of religious liberty and equality, which has been one of the most remarkable characteristics of the reign of Queen Victoria, could hardly have been more becomingly inaugurated than by the compliment which sovereign and city paid to Sir Moses Montefiore, in knighting and electing to the mayorality of London, a Jew.

In 1860 Austria gave the people parliamentary government; in 1867-8 Great Britain admitted the laboring classes to suffrage; in 1868 Spain dismissed the queen and organized on universal suffrage; in 1870 Italy became one free, self-governed kingdom; in 1870 France, by the fall of royalty, resumed constitutional liberty, and became a republic.

The abolition of imprisonment for debt, and the discontinuance of dueling, and its illegality, are distinct indexes of the general progress among the European nations.

The people may be said to have governed in Great Britain about sixty years, and in all the countries of Europe, except Russia and Tur-

key, are governed by law instead of despotism—accomplished during this century.

One grand feature distinguishes modern from ancient Europe—the personal ambitions of sovereigns and their quarrels no longer rule international politics, and decide the destinies of millions. A marked exhibition of personal ambition would combine the neighboring sovereigns in efforts to keep the peace.

Early in the century compulsory education was adopted in Prussia (1815), and later (1833-44) in Switzerland. Law establishing universal education in France, 1833; same year, first assistance to public schools in Great Britain; in 1842, universal education in Sweden; manual training schools in Sweden in 1876; in 1882, compulsory education in France.

With varied degrees of progress, in spite of occasional setbacks, liberty, education and advancing civilization have characterized Europe during the century.

JAMES RUSSELL LOWELL.

[Born 1819. Died 1891.]

The leading trait which characterizes both his prose and his poetry is moral nobility, both of mind d character, and this trait is, in his criticisms, combined with an acuteness, a keen insight, that sees o the very heart of an author, and grasps at once his essential and main purpose. It is generally pposed that the poetical and critical faculties are antagonistic, and that, if combined, one impairs the wer of the other. But in Mr. Lowell the opposite appeared to be true.

CHAPTER XXXIX.

AMERICAN PROGRESS.

GROWTH OF THE NATIONAL DOMAIN—INCREASE OF POPULATION—EXPANSION OF THE SOUTH—COMPLETE SHOWING OF THE CENTURY'S PROGRESS.

THE history of the world gives no parallel to the progress accomplished by the United States during the present century. The original thirteen states, with a population of 3,000,000, had increased to sixteen states with 5,000,000 population in 1800. The country had recovered from the effects of the revolution, and manufactures and the arts were fairly under way. In the colonial days the American provinces were not allowed to make so much as a horseshoe nail, but must import all manufactures from the mother country. Freed from British rule, they at once began to produce their own supplies, and entered upon the new century with great enterprise.

The first twelve years were tranquil years. The war of 1812 was ended in 1815, and a long career of peaceful prosperity continued until 1860. The sixteen states had in 1860 become thirty-four, with a population of 32,000,000.

March 4, 1789, the territory of the United States contained 827,844 square miles in the thirteen original states and the territory they claimed. In 1803-5 Louisiana and Oregon were acquired, consisting of 1,171,931 square miles. The Florida purchase added 59,268 square miles. In 1845, 376,163 square miles were gained from Texas, 545,753 square miles ceded from Mexico, and the Gadsden purchase, in 1853, added 44,064 square miles. In 1867 Alaska was purchased from Russia, with 532,409 square miles, making in all an area of 3,558,009 square miles, or an increase of more than fourfold in less than eighty years. In 1800 Ohio was the western frontier. Indians scalped prisoners on the banks of the Miami in the beginning of the century. In 1800 the United States occupied a narrow border of land on the Atlantic. In 1900 it extends from the Lakes to the Gulf, and from the Atlantic to the Pacific.

The statistics showed, in 1860, six million horses, two million working oxen, eight million cows, fifteen million other cattle, twenty-two million sheep, and thirty-three million hogs. The cotton crop a million tons. The grain crop was twelve hundred million bushels. The tobacco crop was five hundred million pounds. There were five thousand miles of canals, and thirty thousand miles of railroads. The textile manufactures of the country had reached the annual value of two hundred million dollars. There were one hundred and thirteen

thousand schools and colleges, employing one hundred and fifty thousand teachers, with revenues amounting to nearly thirty-five million dollars, and were attended by five and a half million pupils. There were fifty-four thousand churches, with accommodation for nineteen million hearers. There were four thousand newspapers, which circulated annually one thousand million copies.

Then came the civil war, between the North and the South. Reckoning the men engaged, the losses of men and property, the enormous cost, the territory over which the conflict raged, and the far-reaching consequences, it was the greatest war recorded in the annals of time. It not only set free 4,000,000 slaves, but it established the unity of the nation by annihilating the doctrines of state rights and the right of secession, and by the final arbitrament of the sword, decided all the questions that had caused sectional strife.

In the manner of the closing of the war, and its treatment of the conquered, the nation gave an example of magnanimity that challenges the admiration of men in all coming time. General Grant, at Appomattox, declining to accept the sword of Lee, illustrated the treatment that the conquerors gave the conquered. The South made no terms, was powerless to do so. She lay wholly at the mercy of her conqueror. The great purposes for which she had striven so bravely had been rendered forever unattainable. Slavery was extinguished. It was written in the blood of thousands of slaughtered men, so that the whole world could read that America was a nation, and not merely a temporary association whose existence was terminable at the pleasure of any of its members. The South accepted in good faith the decision of the sword. The North, singularly merciful in her use of victory, inflicted no penalty on those whom she had defeated. It was her sole concern now "to bind up the nation's wounds, to cherish a just and lasting peace among ourselves and with all nations." In 1868 General Lee said he could "promise for the Southern people that they will faithfully obey the constitution and laws of the United States, treat the negro with kindness and humanity, and fulfill every duty incumbent upon peaceful citizens, loyal to the constitution of their country." The war not only destroyed slavery, but forever dissipated the state-rights theories of John C. Calhoun (1782-1850) and Jefferson Davis (1808-1889), and forever established the indestructible union of indestructible states.

The close of the war, and the return of peace, marked as remarkable a state of things as was ever before seen on earth. General John C. Black, one of its heroes, describes it: "When the sun rose on the 8th of April, 1865, a million and a half of men on the American continent were seeking each other with arms in their hands, intent upon mutual destruction. Hostile camp fires burned in fifteen states of this Union. Great palls of smoke were massed around Selma and Mobile and Petersburg and Richmond. Every highway and byway, almost,

of the South was occupied with contending forces.

"The historic 9th came and passed!

"When the sun rose on the 10th of April this whole vast area, as by the transformation of a theater, bore a new aspect. War had ceased. Armies were fraternizing. The end of the great rebellion had come, and come in a day.

"To his adversaries Grant's words opened up new hope, and his gauntleted hands directed their steps from red bivouacs back over old pathways to their homes. He told them to rebuild those homes, secure from the consequences of their past, and responsible only for their future acts. The nation magnanimously ratified his pledge, and thus the men in gray marched from the scene of their great struggle and gallant contests, never to be reassembled.

"And that other army, their victorious countrymen, without a flagrant note of exultation, in the presence of the vanquished, lifting on high their victorious ensigns, turned from the front and melted, as an organization, from the face of the earth.

"By the speediest roads of travel these men marched back to their own dear, long-abandoned abodes. They surrendered their faithful arms to the keeping of their government; their flags they hung up in memoral halls; their fame they bequeathed to their country and to the world.

"What have they done since 1865? They have been building railroads, opening mines, subduing wild regions, drawing streams of living water down irrigating channels and making thus the wilderness to blossom like the rose. They have been extending the blessings of self-government to wide regions where the buffalo ranged and the wolf sentineled the passing night. Their cities rise where the lone tepees stood. They have become prosperous farmers, great merchants, leaders in finance, captains of industry. Their uniforms have been replaced by the uniforms of toil. They push the plane, they ring the anvil, they hold the plow. They have brought to the sacred desk the devout service of consecrated powers and eloquent tongues. They who learned the weaknesses of human nature amid the horrors of the hospital have administered with the gentle skill of healing knowledge to the sick and afflicted, and in high tribunals of justice they have inscribed with the pen on the tablets of the law what they strove for with the sword. They have been making states. They have become representatives, senators, governors, presidents. In foreign lands they have illustrated the dignity and glory of the republic, both in public and private stations.

"That some have fallen by the way is true, but the uncountable majority have been worthy of American citizenship, and in the fields of labor, thought, purpose, invention, enterprise, daring and genius, they have ranked with the foremost of this illustrious century. They have inwrought the things for which they strove with the very fiber of the government and the fabric of the age. They have shaped constitu-

tions and laws to the purpose of liberty, the union of the states and the high destinies of the republic.

"Now that the invincible assails them, now that the stars in their courses fight resistlessly against them in their age, the survivors, becoming more and more conspicuous, are lifted upon the very mountain peak of American affection and American pride. There they stand —the survivors—their history secure. And, though folly or ignorance may write of that history in abounding error; though sculptured urn may lie, the uplifted bronze be but the effigy of misrepresentations, the historic page be but the annal of false pride and false sentimentality; though all men's mischievous art should seek to exalt error and distort the truth; though the loving and flattering tongue of kindred and association should palliate error and pervert the truth, yet, trust me, that monumental mountain and grave-strewn plain, inscribed with the deathless names of battles and their heroes fallen in liberty's cause and kept by her sacred power, will blazon and display the luminous truth.

"The constitution witnesses the truth. The republic, undivided and indivisible, perpetuates the truth. All uplifted humanity tells and will tell to latest time who and what were victorious and where was the living truth.

"Let no man be disturbed about the history of the war. It is not written by man's hands, nor changed by man's cunning brain. It is written by the finger of God all over the glowing years. It is kept on the granite fronts of mountains that lift above the clouds; on the unceasing currents of rolling streams; in the names of villages, cities, counties and states. It is stamped all over the face of this broad continent and treasured wherever liberty has followers and freedom devotees. Poetry tells its glorious acts. All the ages step to the measure of the union drums and stir to the call of the union bugles, and lift themselves up to the measure of the deeds of the union's sons. Our eagles tell it to the stars. It mingles with the sea songs of strife and victory. It is blown by the free winds about the globe. It is the history of established liberty and law and advancement."

Notwithstanding the enormous national debt of $3,000,000,000, the nation at the close of the war at once addressed itself to the conquests of peace. The northern army melted into and mingled with the community. The people of the South sought to recuperate their impoverished resources. The national debt began to diminish, and in 1897 was but $1,750,000.000, The population increased marvelously. The 32,000,000 of 1860 became 38,000,000 in 1870, 50,000,000 in 1880; and about 63,000,000 in 1890, and in 1900—more than 70,000,000. During one decade more than 4,500,000 foreigners immigrated to the United States, from Great Britain, Germany, Ireland, Italy, Russia, and all the corners of the earth.

Once the United States imported millions of dollars worth of necessities; now, comparatively few.

There are 1,000 cotton factories and 3,000 woolen factories giving employment to 600,000 persons. Our iron works employ 140,000 persons, and our production of pig-iron is 3,750,000, tons. In 1898 the United States produced thirty-five per cent. of the world's manufactures; its agricultural resources were forty per cent. of that of all other countries combined; its mineral wealth surpassed that of any other nation, and its total wealth was twenty-five per cent. greater than that of Great Britain, twice that of France, and equal to that of Russia, Austria, Italy and Spain combined.

The South has steadily progressed since the war closed. Capital has flowed thither. More cotton is raised than by slave labor. Cotton factories are supplanting those of New England. Mines of coal and iron are multiplying. Great cities are springing up. The freed slaves are constantly improving. Loyalty and fraternity are increasing, and there is every prospect that the twentieth century will find the cement of brotherly love as firmly uniting the North and the South, as it now does the East and the West.

The thirteen original states, in the order in which they ratified the Constitution, are:

1. Delaware.....1787
2. Pennsylvania.....1787
3. New Jersey.....1787
4. Georgia.....1788
5. Connecticut.....1788
6. Massachusetts.....1788
7. Maryland.....1788
8. South Carolina.....1788
9. New Hampshire.....1788
10. Virginia.....1788
11. New York.....1788
12. North Carolina.....1789
13. Rhode Island.....1790

The following were admitted before the beginning of the century:

14. Vermont.....1791
15. Kentucky.....1792
16. Tennessee.....1796

There were sixteen states in the Union at the beginning of the Nineteenth Century. The rest of the states have entered the Union in the following order:

17. Ohio.....1802
18. Louisiana.....1812
19. Indiana.....1816
20. Mississippi.....1817
21. Illinois.....1818
22. Alabama.....1819
23. Maine.....1820
24. Missouri.....1821
25. Arkansas.....1836
26. Michigan.....1837
27. Florida.....1845
28. Texas.....1845
29. Iowa.....1846
30. Wisconsin.....1848
31. California.....1850
32. Minnesota.....1858
33. Oregon.....1859
34. Kansas.....1861
35. West Virginia.....1863
36. Nevada.....1864
37. Nebraska.....1867
38. Colorado.....1876
39. North Dakota.....1889
40. South Dakota.....1889
41. Montana.....1889
42. Washington.....1889
43. Idaho.....1890
44. Wyoming.....1890
45. Utah.....1896

TERRITORIES.

New Mexico.....1850
Utah.....1850
Arizona.....1863
Alaska.....1868
Indian.....1834
District of Columbia.....1790
Oklahoma.....1890

The war with Spain in 1898 added 10,226,664 population and 161,485 square miles to the United States, as follows:

Name.	Area.
Philippine Islands	114,650
Cuba	41,655
Porto Rico	3,670
Sulu Islands	950
Caroline Islands	560
Total	161,485

The new empire acquired by the American Republic in the war with Spain is vast in area, rich in resources, and teems with populations of many kinds. Of this empire there is one part very important to the United States in many ways. That is the Philippine Islands. Spain surrendered to the United States all her possessions in America and all but an insignificant fraction of her possessions in the East. By this surrender, Spain has been practically bereft of colonies. And these colonies, with all their tropical wealth and splendor, have been added to the national wealth of the United States, or, to speak more accurately, serve to establish the first colonies of America. In the opinion of most wise men now in the capital the people of the United States are now entering upon a new experiment. Their first experiment was that of a modern republic; their second and last is that of American colonies. If they succeed in the last as brilliantly as they have succeeded in the first, there will be no cause for complaint from any quarter.

July 6, 1898, the resolution in favor of the annexation of the Hawaiian Islands was carried in the Senate by forty-two votes against twenty-one. President McKinley promptly attached his signature, and 4,000,000 acres of territory were added to the United States.

The principal cities of the United States and their population are as follows:

	1870	1900 (estimated)
New York and Brooklyn	1,338,391	3,200,000
Chicago	298,977	2,200,000
Philadelphia	674,022	1,300,000
St. Louis	310,864	475,000
Boston	250,526	470,000
Baltimore	267,354	470,000
San Francisco	149,473	320,000
Cincinnati	216,239	310,000
Cleveland	261,353	300,000
Buffalo	117,714	275,000
New Orleans	191,418	260,000
Pittsburg	86,076	250,000
Detroit	79,577	220,000
Milwaukee	71,440	210,000
Washington	109,199	200,000
Newark	105,059	200,000
Minneapolis	13,066	190,000
Jersey City	82,546	175,000
Louisville	100,752	175,000
Omaha	16,083	175,000
Rochester	62,386	150,000
Kansas City	32,260	150,000
Providence	68,904	150,000
Denver	4,759	140,000
Indianapolis	48,224	120,000
Los Angeles	5,728	110,000

THE CHICAGO FIRE.—The wonderful recuperation of the city of Chicago, after the great fire of 1871, justifies its mention as an illustration of the triumph of man over his adversities. It was the most destructive fire known in the history of the world, except in loss of life. Only 200 lives were lost against 1,000 in the London fire of 1666. But the property loss was $190,526,500; the acreage swept was 2,000, of

THE SKELETON OF A GREAT STRUCTURE.

"The laying of the corner stone of the Chicago Post Office, by President McKinley, was a notable occasion."

QUEEN VICTORIA'S JUBILEE.

eighty were swept in one hour
iteen minutes; the fire lasted
-eight hours, against four
the London fire, and a day
half in the great Boston fire
; there were 25,000 buildings
red of 53,753 in the entire
8,500 people were rendered
ss. And yet the entire burnt
was rebuilt within three
and with an outlay far exceed-
value of the property before
e.

of the many phenomena of
in which this century has sur-
any other is seen in Chicago.
llowing figures speak beyond
ry words: The population in
was 70; in 1840, 4,853; 1850,
; 1860, 112,172; 1870, 298,977;
03,185; 1890, 1,099,133; 1896,
35; 1900, 2,000,000.

ten largest cities in the world
ndon (census of 1891), 4,231,-
reater New York (estimate
), 3,200,000; Paris (census of
2,447,957; Chicago (police
, 1899), 2,088,000; Berlin
s of 1895), 1,677,351; Canton,
(estimated), 1,600,000; Vienna
s of 1891), 1,364,548; Phila-
a (latest estimate), 1,250,000;
Japan (census of 1893), 1,214,-
t. Petersburg (census of 1892),
39.

than fifty years ago San Fran-
was a mere trading post,
s away from our cities. It
escribed as "a small village
sed of a few adobe houses and
hundred inhabitants," and a
city within the limits and
the control of Mexico; Los
es, as a little pueblo of Spanish
people; now it is a splendid city of more than 100,000 people. The whole population of California in 1850, the year subsequent to the rise of the gold fever, at which time it had been largely increased, was about 90,000; but it grew in two years to nearly three times that number, and now boasts a population of 1,500,000. San Francisco is rated at more than 300,000, the seventh city of the union, Brooklyn being absorbed in New York; and it is the fifty-fifth city of the world. Among the antipodes similar marvels are apparent. Melbourne, in Australia, was founded in 1837, the year of the queen's accession; its population is now 500,000, equal to that of Boston, a city four and one-half times its age. The Australian continent now shows, with neighboring islands, great and prosperous English colonies, with free governments, a large portion of which have agreed upon a federation like that of the Dominion of Canada. The whole continent of Africa has been explored within fourscore years, and immense regions have been opened for colonization by European nations.

A century ago there were but thirteen states, containing less than 4,000,000 inhabitants. Now there are forty-five states, four territories and the District of Columbia, with a total population of more than 70,000,000. The forty-five states of North America, composing the Federal Republic, together with four organized territories, the Indian Territory, and the District of Columbia, extend from the Atlantic on the east to the Pacific ocean on the

west, from the Dominion of Canada on the north to the Republic of Mexico and the Gulf of Mexico on the south. The distance across the United States, from east to west, through the center, is about 2,600 miles, and from north to south, is about 1,600 miles. The shortest distance between the Dominion of Canada and the Gulf of Mexico is about 800 miles. The longest distance east and west from the eastern boundary of Maine to the island of Attu, Alaska, is 7,000 miles.

M. G. Mulhall, a British statistician has, in the "North American Review," an article on the progress of the Pacific states, under which term Mr. Mulhall includes California, Oregon, Colorado, Washington, Utah, Montana, Wyoming, Nevada, Arizona, Idaho and New Mexico. Discussing first the mineral wealth of the group of states, Mr. Mulhall, referring to the census of 1890, says that the total mineral output for that year was $142,500,000, of which all but about $30,000,000 consisted of gold and silver, and that since 1890 these states have averaged fifty-five tons of gold and 1,800 tons of silver, "worth $100,000,000, which exceeds the value of precious metals that any country has yet produced in the history of mankind."

Great as is the mineral wealth of these states, Mr. Mulhall finds that the output of gold and silver is but small in value compared with the value of farm products and manufactures, the farm products being nearly three times the value of the gold and silver. The value of the manufactures is still greater than that of the farm products, though manufacturing is still in its infancy on the Pacific slope. In the matter of horses, cattle, sheep and pigs, taken collectively, Mr. Mulhall finds that there are eight head to each inhabitant in the Pacific states to three in the prairie states, and less than three in the Union at large. The Pacific states also spend more money proportionately upon public schools than the rest of the Union, yet have a greater per cent. of illiteracy. In respect to transportation, Mr. Mulhall finds that "they possess more miles of railway than any European state except France or Germany, and their wealth exceeds that of Sweden, Norway and Denmark in the aggregate."

Statistics such as these are of value in enlightenment, even to Americans, commonly supposed to be duly impressed with the magnitude and possibilities of their country. When it is considered that these states on the Pacific have practically grown up since the discovery of gold in California, less than fifty years ago, and that their development is still within the initial stage, as respects agriculture and manufactures, and possibly also as to mining, it requires a statistician, gifted with prophecy to indicate their possibilities in the future.

Estimate in round numbers of population of the United States in A. D. 1900:

State.	Population.
Alabama	1,800,000
Arkansas	1,600,000
California	1,600,000
Colorado	850,000
Connecticut	850,000

	Population.
.....	200,000
.....	650,000
.....	2,250,000
.....	250,000
.....	5,000,000
.....	2,350,000
.....	2,350,000
.....	1,800,000
.....	2,250,000
.....	1,400,000
.....	750,000
.....	1,350,000
s.....	2,650,000
.....	2,650,000
.....	2,150,000
.....	1,500,000
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.....	360,000
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.....	60,000
iire.....	410,000
.....	1,850,000
.....	6,900,000
na.....	1,860,000
a.....	450,000
.....	4,400,000
.....	500,000
.....	6,250,000
l.....	420 000
na.....	1,450,000
a.....	800,000
.....	2,100,000
.....	3,000,000
.....	310,000
.....	350,000
.....	1,850,000
.....	850,000
a.....	950,000
.....	2,150,000
.....	200,000
round numbers.....	80,000,000
f Spanish territory..	10,000,000
mbers.....	90,000,000

ncial improvement in the tes has been phenomenal. d of the Revolution "not ontinental," was a com- ssion. During the sum- 80 this wretched "continental" currency fell into contempt. As Washington said, it took a wagon-load of money to buy a wagon-load of provisions. At the end of the year 1778, the paper dollar was worth 16 cents in the Northern states, and 12 cents in the South. Early in 1780 its value had fallen to 2 cents, and before the end of the year it took ten paper dollars to make a cent. In October Indian corn sold wholesale in Boston for $150 a bushel, butter was $12 a pound, tea $90, sugar $10, beef $8, coffee $12, and a barrel of flour cost $1,575. Samuel Adams paid $2,000 for a hat and a suit of clothes. The money soon ceased to circulate, debts could not be collected, and there was a general prostration of credit. A barber in Philadelphia papered his shop with bills, and a dog was led up and down the streets smeared with tar, with this unhappy money sticking all over him. A worthless currency early in the century, no gold, and after 1834 only foreign silver; in 1812 depreciated paper, and after the Civil war the national banknotes, worth only about a third of a dollar! A gold dollar was worth $2.85 in paper. Now United States paper is at par, and American gold and silver are current all over the civilized world. In 1790 only three per cent. of the people dwelt in cities, of which there were but six, with a population exceeding 8,000. Philadelphia was the largest, with 42,000. New York came next with 33,000. In 1890 there were 437 cities, with more than 8,000 each, containing twenty-nine per cent. of the population.

Property qualification in New York was required of all voters until 1821, when suffrage was opened to all tax-payers, and in 1826 universal manhood suffrage was adopted.

Religious freedom has had a great growth within a comparatively few years. In Great Britain many restrictions have been removed from Catholics and Dissenters. In this country the Episcopal church in Virginia, and the Congregational in New England, ruled the conscience and the purse with iron hands. Both were supported by compelled taxes. In Connecticut the new constitution did not allow religious freedom until 1818. Now no religious test precedes suffrage.

The great political progress of this country is seen in the overthrow of the state rights doctrine, and the consolidation of the nation with a big N. Most of the people of the southern states held that the unio was a temporary confederacy, di soluble at pleasure. The prevalen opinion at the North was that it wa an indestructible union. The suic dal heresy was violently asserted i South Carolina, under the lead Calhoun, but it was scotched, thoug not killed, by Jackson. It becam most formidable in 1861, and seeme likely to triumph, but the Civil wa crushed it into fragments. Th evolution of the Union from a mer confederation to an indestructibl nation, was the reward of the gre struggle of 1861-65. In the Unite States, the voice of the people the law; equality of rights; n slavery, popular education, religio freedom, progress into wider libe ties—this is the status after a centu of national existence, acknowledge by the people of the South, no le than by those of the North.

SAMUEL WHITBREAD.

[Born 1758. Died 1815.]

The mighty exertions and unflagging zeal of Wilberforce have caused his name alone to be identified with the abolition of the slave trade; but nevertheless a share of the honor is due to Samuel Whitbread, who fiercely denounced this legal traffic in human flesh and blood, and who as fiercely denied, when it was proposed to compensate those engaged in it, that any vested interest could be claimed by them, who morally if not legally had been wrongdoers from the very beginning.

CHAPTER XL.

PRISON REFORM.

EASE IN HUMANITY IN TREATMENT OF CRIME—ELIZABETH FRY—
IEA DIX—ROMILLY—PROGRESS IN A HUNDRED YEARS IS FROM BAR-
TO CIVILIZATION.

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marked improvement in
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Jeremy
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Samuel Romilly (1757-
James Mackintosh
Alexander Maconochie,
aviland, Alphonse Ber-
abeth Fry (1780-1846),
Dix (d. 1887), Walter F.
15), Theodore Dwight,
rs Charles Spear and
Spear, the "Prisoners'
Friends;" Edmund Du Cane, the head of the English Prison System, J. J. P. Vilain (1712-1777), the father of modern penitentiary science reform, Z. R. Brockway, Warden Pillsbury, F. H. Wines, E. C. Wines and multitudes of others.

ROMILLY AT HIS STUDIES.

There were, in 1800, no less than 223 crimes in England punishable by death. It was hanging to appear in disguise in public; to injure Westminster Bridge, to shoot at rabbits, to steal five shillings, and for other trivial crimes. And the condition of prisons and prisoners was horrible in the extreme. The jailor was remunerated by fees extracted at his own pleasure, and often by brutal violence, from the wretches who had fallen into his power. It was his privilege to sell their food to prisoners, and to supply, at an extortionate price, the straw which served them for beds, unless they were content to sleep on

the damp floor. To be acquitted of the charge on which he had been arrested did not imply that the prisoner was to regain his liberty. The payment of certain fees was an indispensable preliminary to the opening of the prison doors; and many who had been declared innocent of crime were detained for years, because they were unable to satisfy the exactions of their jailors. The rooms in which the prisoners lived were small, dark, damp, and ordinarily crowded. No bed was provided; there was no ventilation; vermin swarmed; prison fevers from time to time swept off the unhappy captives. No provision was made for separation of the sexes. The child arrested for some petty offence was at once introduced to the society of old and hardened offenders, and subjected to its inevitable contamination. Lord Cockburn's description of an Edinburgh prison is applicable to prisons generally, a hundred years ago. "A most atrocious jail it was, the very breath of which almost struck down any stranger who entered its dismal door. It was very small; the entire hole being filled with little dark cells; heavy manacles the only security; airless, waterless, drainless; a living grave. One week of that dirty, fetid, cruel torture-house was a severer punishment than a year of our worst modern prison." Such were prisons all over the so-called civilized world a hundred years ago.

Elizabeth Fry relates that in Newgate Prison, "in four rooms, not over large, were found crowded three hundred women, many of them having with them their children, some tried, and other untried, with only one man and one woman to take charge of them by night and day. Though military sentinels were posted on the roof, such was the prevailing lawlessness among these women that the Governor of the Prison entered that department with reluctance, and advised the ladies to lay aside their watches before going in. In the Women's Department, the railing was crowded with half-naked women struggling together for the front situation with the most boisterous violence, and begging with the utmost vociferation. I felt as if I were going into a den of wild beasts, and shuddered when the door was closed upon me."

Then it was a capital offence to steal from a person or from a shop an article of the value of five shillings, or from a dwelling or vessel on a navigable river an article of the value of forty shillings. Thus theft was growing to be a privileged occupation, the following of which could not be effectively reached by law. The penalty was tremendous, but the machinery which alone could inflict that penalty refused to be put in operation.

Military and naval discipline in England was preserved by the lash, five hundred lashes for a small offence. In 1815 Lord Palmerston opposed a law limiting punishment in the army or navy to one hundred lashes. Only in 1866 was flogging in time of peace abolished.

The Connecticut State prison from 1773 to 1827 was an abandoned mine into which prisoners were thrust at

THE WILLARD FOUNTAIN.

"Frances E. Willard gave its motto to the W. C. T. U., 'For God and Home and Native Land'"

A HEALTH TO THE BRIDE.

"At the beginning of this century, the American people were almost a nation of drunkards."

night—their feet chained to iron bars. All American prisons were similar.

The horrible torments of the insane and criminals, as found and described by Dorothea Dix, in the most advanced communities of Christian America, are now incredible. Scarcely fifty years ago she found insane persons confined in cages, closets, cellars, stalls, pens; chained, naked, beaten with rods, and lashed into obedience. In Groton, Massachusetts, she found a young man with an iron collar round his neck, and chained in a small wooden building apart from the almshouse, sitting month after month in darkness and alone. In many of the other States, and in Scotland, Russia, Sweden, Norway, Germany and elsewhere she found a worse condition of things, if possible. As lately as 1848 she declared in her memorial to Congress: "I have myself seen more than nine thousand idiots, epileptics, and insane in these United States, destitute of appropriate care and protection." More than any other person, not even excepting John Howard and Elizabeth Fry, she heard the cry of the prisoner and helped him. (See "Medicine.")

Perhaps the glimmer of the dawn was when Pope Clement XI (1649-1721) in 1704 inscribed over the door of the Hospital of Saint Michael in Rome, "For the correction and instruction of profligate youth, that they who when idle were injurious, may when taught become useful to the State." In the hall where the boys worked he inscribed: "Parum est coëcere improbos poenâ nisi probos efficias disciplinâ," translated by Howard: "It is of little advantage to restrain the bad by punishments, unless you render them good by discipline."

The idea of punishment producing reformation was accelerated in the fermentation of thought resulting from the French and American revolutions, and found its greatest embodiment in the immortal John Howard (1726-1790). He visited the prisons of one county in England after another; and at last, after having seen most of the town and county jails of England, he accumulated a mass of information, and laid it, in March, 1774, before the House of Commons. From this date the reform of prisons begins. Who can describe the depth of prison degradation at that time? The cells noisome, the food of the coarsest, little straw, damp walls, narrow cells, bad water, sexes huddled together, stagnant mire, dunghills within the walls, brutal jailors, months of unjust imprisonment before trial, no regard to health or decency, and jail fever decimating the miserable inmates. At Ely the prisoners by night were chained down with iron bars and had on iron collars full of spikes.

Edmund Burke says of Howard: "He has visited all Europe—not to survey the sumptuousness of palaces or the stateliness of temples; not to make accurate measurements of the remains of ancient grandeur; not to form a scale of the curiosities of modern art; not to collect medals or collate manuscripts; but to dive into the depths of dungeons, to plunge

into the infection of hospitals, to survey the mansions of sorrow and pain; to take the gauge and dimensions of misery, depression, and contempt; to remember the forgotten, to attend to the neglected, to visit the forsaken, and compare and collate the distresses of all men in all countries. His plan is original; it is as full of genius as of humanity. It is a voyage of discovery, a circumnavigation of charity."

At the beginning of this century the eminent lawyer, Sir Samuel Romilly (1757-1818) introduced bills in the English Parliament, and exerted his great abilities in reforming the penal code, and to him must be ascribed the credit of beginning by legislation the modification of penalties that have, for a hundred years, been growing more and more humane. "Few persons," said Lord Brougham, "have ever attained a celebrity of name and exalted station, in any country or in any age, with such unsullied purity of character as this equally eminent and excellent person."

Sir James Mackintosh took up with success the cause of the overpunished criminal. In 1820 it ceased to be a capital offence to poach by night; unless, truly, the offender blackened his face, for which enormity no pity could be shown. The protection of the gallows was now withdrawn from Westminster Bridge. A gipsy might at length remain for a year in the same locality without danger of expiating his wickedness by death. Even a known thief found in one of the northern counties might hope to live unharmed if he did not anew provoke the resentment of the law.

Very slowly the relaxation proceeded until 1832, when the progress became less timid. During the next few years many crimes ceased to be punished by death. It was long before the mitigation reached the stealing of cattle and sheep, that being an offence against the majesty of the agricultural interest. The legislature manifested an impartial reluctance to spare the forger. At first, Parliament consented to exempt only certain classes of forgeries; and it cost several years, and three several acts of Parliament, before forgery of every degree ceased to be visited with death. After 1834 it was no longer permitted to behead the body of the slain criminal, or dissect it, or hang it in chains. Hitherto the counsel of a prisoner under trial for felony was not permitted (except in Scotland) to address the jury on behalf of his client. In 1836 that privilege was conceded, not without considerable opposition. Until that year a criminal condemned to death had but one clear day between sentence and execution. For that day his sustenance was bread and water, and no friend was allowed access to him. All these needless cruelties were done away with. In 1837 the list of capital offences was further abridged, till it contained no more than seven. The record of sentences passed in these years shows how rapidly the relaxation now progressed. In 1834 there were pronounced 480 sentences of death, but only 116 in 1838. In the former year 894 persons were

sentenced to banishment for life, but in the latter only 266. A few changes had still to be made; but the triumph of mercy, after thirty years of effort, was now substantially complete. A similar reform prevailed in other European countries, and in the United States. In some states capital punishment has been entirely abolished, and in others nearly so.

Systematic measures for the betterment of the conditions of the prisoners are peculiar to the century, such as penalties against interference with transportation; against infringements of patents; against the abuse of power by corporations; against combinations of workmen; against combinations of capital, etc.

Besides these, sanitary and quarantine regulations, laws against dueling, lotteries, and other measures exist for the protection and happiness of mankind, far above the conditions of any previous age; also the multiplication of workhouses and industries, abolition of imprisonment for debt, reform schools for the young, separate ones for the sexes; prisoner classification and prison discipline, separation of sexes, of sick from well, improved prison architecture, and numerous provisions to render punishment certain, severe and salutary.

The Christian church had always provided for the visitation of prisoners as a form of charity, but this century for the first time furnishes and compels physician, chaplain, work, discipline, and all possible means of producing the reformation of the prisoner.

Only a few years since "the crime of being poor" was punishable by imprisonment with felons. Cruel creditors often incarcerated their debtors for months and years, sometimes for the long remainder of a life, for non-payment of debt. Goodyear, the India rubber inventor, suffered ten years thus, and some of the best of men have endured long incarcerations for no other reason than inability to pay what they owed. Now in most countries imprisonment for debt is practically abolished.

The accounts transmitted of the treatment of debtors in England and America in the past century, are harrowing. Thus it is said that in the eighteenth century four thousand unhappy individuals were committed to prison every year for misfortune and poverty, and treated like criminals and outcasts. "One indiscreet compact could doom a wretch to a life-long confinement," a small debt exposed the unhappy person to perpetual imprisonment.

In the United States, even as late as 1829, it was estimated that there were as many as 3,000 of these unfortunate persons confined in the prisons of Massachusetts; 10,000 in New York; 7,000 in Pennsylvania; 3,000 in Maryland, and a like proportion in other states. In many of these debtors' prisons no provision was made for sickness, or even for ordinary cleanliness or comfort. There was often no separation of sexes; and these victims of misfortune were confined with robbers, vagrants and murderers.

Between 1821 and 1845, imprisonment for debt, in the various United

States, was abolished, except in cases where fraud was reasonably suspected.

The Auburn, the Pennsylvania, the Elmira, and the Irish systems of the treatment of criminals adopt different measures looking to the amendment of the criminal. Most prisons are now modeled on one of these systems.

The infliction of indeterminate sentences, to expire when reformation has been effected, is now the prevailing sentiment of the wisest students of crime and criminals. The criminal is regarded as still a man who is to be uplifted and restored, if possible, and that an indeterminate sentence should in all cases be pronounced against him, to end when competent authorities say his reformation is effected. What an advance from ancient abuses, nay, from the common methods of Christian countries less than a century ago!

Jailer Whitman, of the Chicago jail, said recently (1898): "Society has discovered that philanthropy is but the beginning of wisdom, that the brutal and inhuman punishment but serves to increase the evil it is intended to check, and now further demands that we, who have the care of those who have come under the ban of the law, should give thought to this feature of our work. By lack of intelligence in handling them, as well as by lack of feeling, we may further increase the burden which society has to carry in caring for the criminal class." The keynote of the modern successful care and treatment of the insane and imprisoned, is kindness. No man, no matter how hardened by the unfortunate conditions of his environment, can stand out against kindness.

The prison is now for a different purpose to what it used to be. It is still for the protection of society, but by a different method: by the reformation of the criminal, in imitation of all divine punishments. The object of punishment has at last been revealed to the world. It is to cure. So all advanced criminologists in our day are saying that the only way to protect the community is by the reformation of its enemies, the criminal classes. The purpose of the Prison Reform associations is to make the whole prison system conduce to the improvement and cure of the convict. It is to make the enemy of society into a friend. Hence, the $400,000,000 used in the maintenance of the prisons in the United States must result in good to the whole people. Says Mr. Wolfer, the warden of the Minnesota Prison: "The prison keeper who tries to hold men on brute principles inevitably becomes brutish himself." Corporal punishment, he says, not only hardens the criminal, but it brutalizes the one inflicting it.

In 1824 the first American reformatory was founded, the New York House of Refuge. The latest statistics show that millions are invested in a large number of institutions for youthful criminals, and that nearly three-fourths of them are reformed.

In 1877 the beneficent indeter-

minate sentence was initiated in Elmira, New York.

Twenty-five years ago prison managers acted upon the principle that prisons are to punish men for committing crime. To-day, they believe that prisons are, or should be, hospitals to cure men of crime. Punishment, to be sure, but they have learned, from a better understanding of Christianity, that punishment is to prune, to cure. So, the old saying, to vindicate the law, or to placate justice, is passing away. Justice requires and demands the reformation and obedience of sinful men. Our prisons are slowly learning to imitate God's method. Revenge is being replaced by a humane purpose of righteous retribution, accompanied by efforts to reform the criminal, as well as to protect society.

Doctor Phillips Brooks (1835) has appropriately said: "The time will come, the time is coming, when the preciousness of every human soul shall be no longer a mere doctrine of the churches and schools, but shall become the soul and shaping power of our softened and humanized institutions. Then shall our prisons become the true re-creation and renewal place of character. Then shall what seemed dead in them be born anew. And, seeking the true man, the Christ, in every prisoner, the eyes of those who seek shall find it, and their hands shall help it forth into activity and light."

And Ex-President Hayes' words are full of truth: "We believe society is so compacted together, that Providence hath so ordained and doth so govern things, that, whether we would have it so or not, we must be, and are, our brothers' keepers. No man's family is safely intrenched against vice and crime, and shame and wickedness to which they lead. Let the outcast and the criminal be forgotten and disregarded, and our whole society will suffer from the taint of human degradation. Like a blood poison, it will spread through and through the social system until it reaches the heart. This serious and mighty truth imposes a duty which no society can afford to neglect. Civilized society cannot neglect it and live. No well-informed Christian society ever will neglect it."

"The progress of mankind in the treatment of crime has been marvelous. There have been four eras in the evolution of criminalism: (1) Vengeance, (2) Repression, (3) Reformation, (4) Prevention. The overthrow of mere torture, or retribution, was effected in the last century by Beccaria and his coadjutors, and by the investigations and grand appeals of John Howard. The impulse that moved mankind onward and upward was set in motion by the democratic ideas that were born in the French and American revolutions. The criminal has been scientifically studied, and the principles of Christianity have been applied to his treatment. Criminal anthropology has become a science. The benevolent work of the nineteenth century throughout the world, is the outward and visible reaction against the barbarity and brutality which, before this century opened, every-

where characterized the administration of the criminal law. The flower of Christian charity has sprung up and blossomed from roots which struck deep into what seemed to be the most unpromising of soils, but which has been enriched by the blood of numberless victims, and watered by the tears of the pitiful."

Nearly all the progress has been accomplished in the Nineteenth Century.

THEOBALD MATHEW.

[Born Oct. 10, 1790. Died Dec. 5, 1856.]

he 10th of April, 1838, Father Mathew headed a weak and inefficient "body" of three—a clergy-
the English Church, a Unitarian, and a Quaker; grand pioneers they were of a great reforma-
the city of Cork. Two years afterwards his temperance troops numbered nearly three mil-
children, women, and men. The words he had uttered when he joined "the three" were these:
goes in the name of God!" He signed their pledge and began the work.

CHAPTER XLI.

TEMPERANCE.

ATIONS WERE RACES OF DRUNKARDS IN 1800—DRINKING AT ORDINATIONS ND FUNERALS—RECHABITES—SONS OF TEMPERANCE—WASHINGTONIANS— C. T. U.—NEAL DOW—MISS WILLARD—MAINE LAW—FATHER MATHEW.

'E are apt to regard our pious pilgrim and puritan ancestry as having been very abstem- But facts dispel the illusion. 9 an appeal was sent to the country for "ministers," a nt under seale" that their status as colonists might be nd stable, and also they want planters," wheat, rye, barley, so "hop rootes." When the r to this appeal was sent by a hat was provisioned for three s it carried "forty-five tuns of " "two casks of Malega and e," "twenty gallons of aqua (brandy) and for cooking, ng, and all, only six tuns of " Those hop roots must have hed, for as early as 1631 the of the colony had passed a r putting drunkards in the and brewhouses multiplied, "ale quart of beere," could ght for a penny. The manu- of other drinks developed . Fifty years after Judge mentions ale, beer, mead, glin, cider, wine, sillabub- sack, canary, punch, sack and black cherry brandy. body drank cider, which was ed on every farm in abundance. Besides these, there was a "beveridge" and "swizzle" made from molasses and water and many kinds of beer, but the grand and universal drink was rum. Ships took corn, pork, and lumber to the West Indies, and brought back raw sugar and molasses, which once here were speedily converted into rum. There was a distillery in every inland town, while those on the coast had scores of them. The significant name "kill-devil" was universally given to rum, and it was shipped to the African coast in exchange for slaves. Thus the twin curses helped each other. "Flip" and "Punch" were made and drunk on all imaginable occasions. Laborers would not work at the harvest, nor builders at the trades, without an allowance of rum.

Large quantities of liquor were consumed when a minister was to be ordained, as is witnessed in many of the parish records, still extant.

Even at a raising of a meeting-house large stores of intoxicants must be laid in. When the meeting-house of Medford, Mass., was raised there were provided four barrels beer, twenty-four gallons West India rum, thirty gallons New England rum, thirty-five pounds of loaf sugar,

twenty-five pounds of brown sugar, and 465 lemons. When, a century ago, General Washington was engaging a gardener it was explicitly stated

FATHER MATHEW.

in the contract that he may have $4 at Christmas, with which he may be drunk for four days and four nights; $2 at Easter, for the same purpose; $2 at Whitsuntide to be drunk for two days; a dram in the morning and a drink of grog at dinner at noon. Every tavern displayed many decanters of liquor to be drunk with all meals, free, and the tip-iron was kept constantly heated in the tavern fire; the sideboard of every private family had a various assortment of liquors, and not to ask a caller to drink was a breach of hospitality; in short, temperance sentiment as we now know it did not exist.

At the beginning of this century the vice of intemperance was general and the habit of drinking alcoholic liquids well-nigh universal. The American people were almost a nation of drunkards. The protest against intemperance was feeble indeed, an occasional lapse was regarded with smiles, rather than blameworthy, and only chronic drunkenness was deemed unmanly.

In England "when people received their friends, it was deemed indispensable that every friend should mark his appreciation of the good fare which he enjoyed by becoming intoxicated. The host claimed it as his due that every guest should drink till he could drink no longer. The supreme crowning evidence that an entertainment had been successful was not given till the guests dropped one by one from their chairs, to slumber peacefully on the floor till the servants removed them. In this country the sideboard was universal, and people in all conditions of life with rare exceptions indulged in intoxicating drinks. The earliest recollections of this writer are of reaching up for the

FRANCES WILLARD.

sweet contents of the bottom of the tumbler, after his father had nearly absorbed the draught. His father died in 1832, when the son was nine.

Nearly everyone drank liquor in the times of Washington, and the father of his country always had wines upon his table. It is nowhere stated that he drank to excess, although he usually consumed five glasses of Madeira wine at dessert. Among the items of his election expenses when he was a candidate for the House of Burgesses of Virginia were a hogshead and a barrel of whisky; thirty-five gallons of wine, and forty-three gallons of beer. (See "Dentistry.")

In 1812 the Rev. Humphrey recommended total abstinence, as did Dr. Lyman Beecher (1775-1863) and various temperance societies arose. Not, however, till 1836 was the American Temperance Union formed on the basis of total abstinence.

The Rechabites were organized in England, August, 1835. The Rechabite pledge is extremely stringent and far-reaching, but the order is steadily increasing in Great Britain, and in the United States, Canada, and Australia. Their lodges are called "tents" in allusion to Jer. xxv:7. It is established upon temperance principles, "so that abstainers could be united together, and have the privilege of a Benefit Society as well."

The poet, Prior, said: "A Rechabite poor Will must live, and drink of Adam's ale."

In 1840 the Washingtonians were founded in Baltimore, and in 1842 the Sons of Temperance were instituted in New York City. From 1845 commenced the various orders, with ritual and insignia, which have gradually been extended to or imitated in Europe. As early as 1818 a total abstinence society, believed to have been the first in date anywhere in the world, had been founded at Skibbereen, in Ireland. The first public temperance society in the United States was organized in 1826. In England the movement began at Bradford, in February, 1830. The British and Foreign Temperance Society was formed in London early in 1834. On August 23, 1832, Joseph Liversey, then a member of the Preston Temperance Society, drew up the teetotal pledge, the first signers of which are known as the "seven men of Preston." This inaugurated the modern teetotal movement. In 1838 Father Theobald Mathew, a Capuchin friar (1790-1856), became the apostle of temperance. The United Kingdom Band of Hope Union was founded in May, 1855. In 1868 the Independent Order of Good Templars, probably the most widespread of all temperance organizations, was planted in England by Mr. Joseph Malins. In 1873 Cardinal Manning (1808-1892) and Father Nugent commenced a vigorous temperance movement among the Roman Catholics. The feeling in favor of temperance is steadily growing, and the numerous societies, with their large membership, constitute a very potent social and political force.

The National Woman's Christian Temperance Union, with its auxiliary state and territorial unions, besides that of the District of Columbia, is the largest society ever composed exclusively of women and conducted

entirely by them. It has been organized in every state and territory of the nation, and locally in about ten thousand towns and cities. The wonderful development of the Woman's Christian Temperance Union into a powerful organizaton, numbering about 1,000,000 paying members, and numerous co-workers, shows what powerful agents honest conviction and unity of purpose are in strengthening and solidifying a large body, no matter how heterogeneous its composing elements may be. For ten years the organization was confined to this country, and not until 1885 did England follow the example of the American women, by establishing a similar society. The British society was founded by Mrs. Margaret Bright-Lucas, the sister of John Bright. Lady Henry Somerset became so interested in one of Frances Willard's books, that she began to correspond with the author, and soon became one of the most active workers of the young organization. Great Britain, Canada and Australia, Hawaiian Islands, New Zealand, India and Japan, Madagascar and South Africa, have also organized, and there are local unions in almost every civilized nation. This society is the lineal descendant of the great temperance crusade of 1873-4, and is a union of Christian women for the purpose of educating the young; forming a better public sentiment; reforming the drinking classes, and securing the entire abolition of the liquor traffic. In its political aspect the temperance question has in this country become one of grave importance, and has formed an issue in more than one political campaign in several states of the Union. Its advocacy has assumed different forms, ranging from partial restriction to total prohibition.

One of the most remarkable revivals any moral movement ever experienced was the Washingtonian Reformation of 1840. It originated with a few men in Baltimore, Maryland, of whom John Hawkins was the leader. It repudiated the aid of the law, and appealed to the moral instincts and impulses alone—"moral suasion." It swept the land like a beneficent tornado, and wrought a wonderful reformation. Thousands were reformed, and a moral standard was created that rendered the drink habit unfashionable and disreputable. But it was found that large numbers of those who were reformed from their cups did not remain temperate. Saloons and dram shops beset them; they were tempted by those who drank, and they fell by thousands after having been rescued. It was seen that moral measures must be reinforced by law; "legal suasion" must succeed and aid "moral suasion," and there came a great and glowing demand for law to suppress the sources of temptation and ruin. Prohibition of the manufacture and sale of intoxicating drinks as a beverage was advocated as absolutely essential to the success of the cause of temperance. The movement began in the state of Maine, and the principle was embodied in what was known as the "Maine Law."

Pre-eminent among its advocates

was Neal Dow, who was born in Portland, Maine, in 1804, and died in 1897. He was always a teetotaler, but became interested in temperance after listening to Justin Edwards, D. D., who was president of the American Temperance Society from 1829 to 1836. He was a constant worker in the cause during his entire liftime, and especially devoted his efforts to securing prohibition legislation. Under his lead a prohibition law was enacted in 1851, as the first one failed to succeed, owing to having no penalty for those convicted.

Mr. Dow, then mayor of Portland, drafted the law of 1851, which passed the legislature by a vote of 104 to 50, on joint ballot. In 1884 he had the satisfaction of seeing the principle of prohibition inserted in the state constitution by a majority of 47,075. In 1861, then fifty-seven years of age, he recruited in the Maine Thirteenth regiment, and went into the Civil war as colonel. In April, 1862, he became brigadier-general. He was twice wounded, and was confined in Libby Prison.

The present Maine law vests the sale of intoxicating liquors in special agents appointed by the state, prohibiting all other persons from such sale. The manufacture of intoxicating liquor for unlawful sale is also forbidden. If an authorized agent violate the law, he is subject to a fine not exceeding $30, and imprisonment not exceeding three months; while the penalty for a violation of the law by a common seller is $100 fine or three months' imprisonment for the first, and $250 fine and four months' imprisonment for the second and every subsequent offense. Any one injured by an intoxicated person may maintain an action against the seller of the liquor, and the owner or lessee of the building in which the liquor was sold is jointly liable, if cognizant that the building was used for such purpose. In Maine, under the earnest efforts of the apostles of total abstinence, prohibition was carried as a measure of state policy, and the Maine liquor law formed the basis of subsequent similar enactments in other states. In several of the states local option exists, and in one—South Carolina—the state has assumed a monopoly of the liquor traffic, allowing no liquor to be sold except through the medium of dispensers appointed by the boards of control, said boards of control in turn being appointed by the governor, with the consent of the legislature. To enforce this law, the governor has authority to employ special constables, whose pay shall be two dollars per day. Iowa has a prohibition law, the provisions of which, especially that portion relating to "original packages," has occasioned much litigation. It is a significant fact that, in the localities in which women are allowed to vote, prohibition is most firmly established as a matter of government policy, and intemperance and its consequent evils are at a minimum.

Theobald Mathew (1790-1856). In middle of life, at the age of forty-eight, after having seen the evils of intemperance in his native Ireland, Father Mathew, with three

other clergymen, an Episcopalian, a Unitarian and a Quaker, put his name to the total abstinence pledge in the city of Cork, exclaiming, "Here goes, in the name of God." He at once began his famous temperance crusade, and in two years he had enrolled the names of nearly 3,000,000 men, women and children under the white banner of temperance. He continued his wonderful labors, extending them to England, Scotland, and the United States, and accomplished one of the most remarkable reformations in history. S. C. Hall (1800-1889), in his "Ireland: Its Scenery and Character," says: "It would require a volume to describe Ireland prior to the advent of the apostle. It is among the most marvelous of modern miracles that the wine and whiskey drinkers of the 'better' classes were led to reason and reflect upon, and ultimately were coverted by, what they witnessed as to the effects of total abstinence in their poorer neighbors and dependents. No doubt, other influences were at work, and largely contributed to induce temperance among those who were out of Father Mathew's reach; but it was not until 1840 that temperance was considered, in Ireland, respectable, and drunkenness degrading; and that was after the good priest had carried conviction to high and low."

Mr. Hall describes the brave apostle of temperance: "rather above than under the middle size; not stout, but not thin; the expression of his countenance was indescribably sweet and winning; the features were sharply cut and prominent; he might have been called handsome, but he had a beauty of person that can never exist without beauty of soul; the mind spoke in the face; it was the language of gentleness, patience, endurance, tenderness, loving-kindness, trustfulness, and hopeful affection, such as I have never seen so strongly marked in any one of the thousands of distinguished and good men on whom I have looked. I could have accepted him as an embodiment of 'the beloved apostle'; and I am very sure he was one of the earth-darlings of his Lord!"

Among the champions of total abstinence in Great Britain, the name of Sir Wilfred Lawson ranks high.

Frances E. Willard (1839-1898) was a highly educated woman, who was professor of natural science and æsthetics, but who abandoned her profession in order to devote her life to the cause of temperance. No woman in this country has been more devoted to, or successful in, labors for purity, temperance and the welfare of mankind. In addition to innumerable articles for the press, she has published several volumes, and her persuasive voice has been heard by millions in this country, and in Europe, pleading for morality and reform. Miss Willard gave its motto to the W. C. T. U., "For God, and Home, and Native Land," and classified forty departments of work.

During the last sixty years the cause of temperance has been advocated by most clergymen of all churches, and by many of the eminent and good of all callings and vocations. The orator par excellence

many years was John B. Gough 7-1886), who electrified millions the force of his eloquence, and no doubt dissuaded thousands ı the vice of drink. Among the .t orators who gave their influ- to the cause were E. H. Chapin 4-1880), Wendell Phillips (1811-), Henry Ward Beecher (1813-), Sylvanus Cobb, Sr., Mary Livermore (1821), Theobald hew, and Dr. Jewett.

here are now laws in thirty-nine s and in all the territories re- ing teaching in schools of the re and effects of alcoholic ks.

rhaps the progress of mankind not been more marked in any rd than in respect to this sub- Those who have reached the of three-score years or more look back to the time of their h and see how different were the ts and customs of the people to e of the present time. New land "rum" was nearly as cheap almost as plenty as water. The nter was on every sideboard. farmer furnished alcoholic ks to his hands without stint. wonderful change that has taken e is illustrated in almost any munity or any home.

hus the reform which first took direction of mere moral sua- addressed to individuals later, red public life and was em- ed in legislation. Maine and ı prohibit the manufacture or of intoxicating liquors to be as beverages, in their state titution. Minnesota has high ıse—allowing liquors to be sold, but exacting a license fee of $1,000 in large cities and $500 in small ones. South Carolina has enacted a state monopoly, thus insuring liquors against adulteration, and making it possible to regulate the sale.

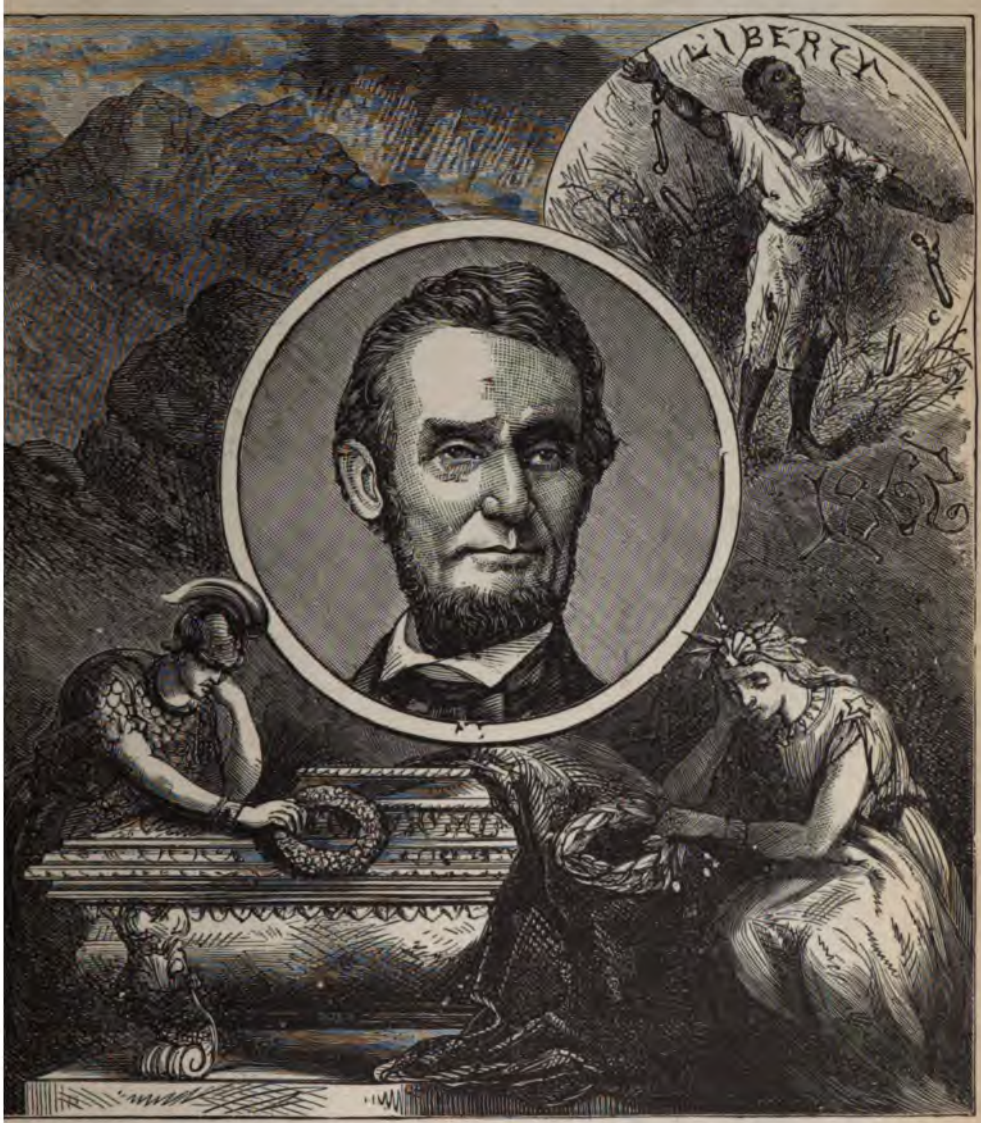
One of the great discoveries with which to counteract intemperance is that of bichloride of gold. It was brought into notice on account of the alleged successful use made of it by Dr. Keeley, of Dwight, Illinois, in the cure of dipsomania and chronic alcoholism. Its general characteristics chemically, posologically, and in physiological action are to a great extent similar to those of mercury bichloride. Its employment by Dr. Keeley has produced a profound impression on the medical world, and many advocates both for and against its virtues exist.

The advances of temperance in this country during the last half century may be thus epitomized: "(1) The geographical area within which prohibition is not only nominal, but actual, has been greatly enlarged, through the operation of local option laws, even in states under the license system. (2) There is a marked tendency to throw additional restraints and safeguards around the liquor traffic, one of which consists in raising the license fee. (3) A method of dealing with the question has been found in applying to the saloon the law of nuisance, under which it can be suppressed, in a court of equity, by the use of the writ of injunction. (4) It is very noticeable that the courts of last resort have, in almost every instance, justified and upheld

the most drastic statutes aimed at this traffic, on the ground of public policy. (5) It is also noticeable that the general course of legislation is in the direction of a firmer control of the traffic by the police and by the courts. It comparatively rarely happens that amendments to the existing laws are made in the interest of the saloon. (6) The attitude of the police to the traffic is undergoing an obvious change for the better. There is a general movement for the suppression of dance-halls where liquor is sold; of concert-saloons, "stall" saloons, private wine rooms, saloon theaters, gaming in saloons, "pretty waiter girls," and all similar practices. (7) The number of arrests for public intoxication is less than it was and tends to diminish. Decreasing intemperance and increasing sobriety are seen in all civilized countries.

ABRAHAM LINCOLN.

[Born 1809. Died 1865.]



He was naturally warm and affectionate in his temper; comprehensive, impartial, and strongly possessed with the love of mankind. In his conduct he probably became independent of passion of any sort, and chose what was just on its own account. Altogether, Lincoln may justly claim high place, not only as an American patriot, but as a benefactor of mankind. His name is enshrined in the hearts of the freedmen as that of their predestined deliverer out of bondage.

CHAPTER XLII.

SLAVERY.

ON OF SLAVE TRADE AND SLAVERY IN GREAT BRITAIN, AMERICA, ZIL AND RUSSIA—WILBERFORCE—SHARPE—GARRISON—PHILLIPS—MRS. WE—UNCLE TOM'S CABIN.

IEN the Nineteenth Century dawned, slavery prevailed throughout the Christian There were 9,000,000 slaves ary, 48,000,000 serfs in Rus- the peasant population of and Austria were virtually nearly the entire colored on of America were slaves, g 600,000 in the West India under British jurisdiction. boasted that there were no n Great Britain, but the col- l salters of Scotland were nd sold with the mines they Besides, British ships Africa of thousands of hap- oes every year, and the Brit- hant marine made its owners he transportation of slaves. tish Parliament sanctioned e trade by many legal enact- From 1800 to 1808, forty l slaves were transported to tinent in British ships.

English slave-trade began John Hawkins in 1562. He ined leave from Queen Eliza- carry Africans to America eir own consent; but he hem on board his ships, not slaughter, and escaped with- ishment, and a few years later he received high honor from the Queen. When Virginia attained a fixed condition as a colony—about 1615, when fifty acres of land were assigned to every emigrant and his heirs—the cultivation of tobacco followed. Five years later, a Dutch ship brought a cargo of negroes from the coast of Africa whom the Virginians joyfully received as slaves. But slavery had no legal sanction. Once introduced, it became chronic; children and grandchildren were born in slavery. In 1645, when slaves were brought to Boston, the magistracy committed the sellers to prison, sharply denounced their crime, and ordered the slaves to be sent home at the public expense. Negro slavery became, however, domesticated in all the American colonies, nor did it wholly cease in the northern section until after the Revolutionary war. At the era of American independence South Carolina and Georgia were the chief slave-holding communities. Through the immense impulse given to cotton culture in the South by the invention of the cotton gin, the number of slaves was nearly doubled in ten years—from 1790 to 1800—going from about 700,000 to 1,200,000 souls. At

length, in 1808, Congress forbade the importation of Africans. By cutting off this source of supply the increase was limited to what slaves were bred within the states themselves; and in forty years more (1860) the period of the civil war, the whole number of slaves was only a little more than 4,000,000."

American negro slavery continued nearly two hundred and fifty years. It was reinforced by the invention of the cotton gin, the adaptedness of the South to cotton-raising, and the fitness of the negro to cotton-culture. It was thought that cotton could only be successfully raised by slave-labor, but it has been shown that freemen are more successful in cotton-raising than slaves, for in 1860 under slavery 4,699,770 bales were raised, while in 1894 the crop was 9,500,00, bales.

In the United States the negro is admitted to full privileges of American citizenship and millions of dollars are expended for his education and elevation. In spite of sporadic outbursts of violence and occasional frightful crimes, the conditions of the black race, measured by its possession of property and its approach to industrial independence, are far better than twenty-five years ago. Compared with the days of slavery the negroes are immeasurably advanced.

Early in the century there was in the English colonies a slave population of nearly 800,000. By the efforts of Thomas Clarkson (1760-1846), Granville Sharpe (1734-1813), and others, a public sentiment was evolved that compelled the abolition of the slave-trade. Later on William Wilberforce (1759-1833), Thomas Fowell Buxton (1786-1845), Stephen Lushington (1782-1873) and others aroused the national conscience. Already in 1785, the vice-chancellor of the University of Cambridge had offered a prize for the best essay on the question whether slavery was right, and the successful candidate was Mr. Thomas Clarkson. Many of his warmest supporters belonged to the Society of Friends. In 1786 William Wilberforce brought the subject before Parliament, but the act abolishing it did not become law till March 25, 1807. Agitation was now directed against slavery itself, and in 1833 the Emancipation Act was passed, which, on August 1, 1834, set free 770,280 slaves in the British West Indies, with a compensation of $100,000,000 to their owners. On August 1, 1838, slavery was abolished in British India.

It was through Granville Sharpe "that the great principle was established, that whenever a slave sets foot on British soil he is free. James Somerset, an African slave, was brought to England by his master in 1769; some time afterward he left his master, who took an opportunity of seizing him, and conveyed him on board a ship, to be taken to Jamaica as a slave. Granville Sharpe supplied the money, the leisure, the perseverance, and the learning required for the great controversy; the case was pleaded with great care before the judges in 1772, with the final result that it was established, to use Curran's (J. P., 1750-1817) eloquent words, 'as the spirit of the

British law, that liberty is inseparable from British soil; that, no matter in what language the man's doom may have been pronounced, no matter what complexion incompatible with freedom an African or Indian sun may have burnt upon him, no matter in what disastrous battle his liberties may have been cloven down, no matter with what solemnities he may have been devoted upon the altar of slavery, the first moment he touches the sacred soil of Britain, the altar and the god sink together in the dust.' "

William Wilberforce was one of the earliest and greatest promoters of the claim of freedom for the African race. On the night of May 13, 1789, in the British House of Commons, he demanded of England that she abandon the slave trade. Nearly twenty years after, his labors and those of the noble English advocates of liberty were crowned with success. On February 23, 1807, the abolition bill passed the House of Lords, 283 to 16. "Slander, insult, the bitterness of hope deferred, the coldness or treachery of friends, the persistent malice of enemies,—all these had the now veteran champion encountered, and over them all had he at length prevailed. 'Sir Samuel Romilly took occasion to contrast the work of Wilberforce with that of Bonaparte. 'The master of armies would lie that night in the Tuileries, and even in his dreams see Europe at his feet. The Apostle of Freedom would seek a less stately roof and a humbler pillow; but over his pillow would hover the glorious certainty that, everywhere throughout the empire on which the sun does not set, the slave, by his and his colleagues' efforts, was at length FREE!' As the words left the speaker's lips, the House rose almost to a man, and, every eye directed toward Wilberforce, burst into a thunder of applause."

In 1829 the Pope of Rome had set the example to Protestant nations, by decreeing the abolition of slavery in Mexico, "for the glory of God, and to distinguish mankind from the brute creation."

The condition of this country when the Nineteenth Century began, cannot be conceived by any one now living. Slavery sat supreme on a throne of skulls, and ruled the state, church, schools, trade, literature, commerce, public opinion, with iron hand. The "peculiar institution," the "patriarchal institution" prostituted millions of God's image in ebony to the level of brute beasts. Robbery, murder, adultery were legalized. Some of the far-seeing patriots, even among slave-holders, foresaw the whirlwind that was sure to be evolved from sowing the wind, notably Jefferson, and warned the nation against the great crime, called by John Wesley "the sum of all villainies," but the institution became more and more securely rooted in the nation, until it threatened to perish only with the nation's life.

The anti-slavery reform in this country may be said to have been inaugurated in 1829, by Benjamin Lundy (1789-1839) and William Lloyd Garrison (1804-1879), when they started the publication of "The Genius of Universal Emancipation."

Mr. Lundy favored the gradual removal of slavery, but Mr. Garrison startled the land by advocating "immediate and unconditional emancipation." Mobbed, imprisoned and fined for his advocacy of abolitionism, his fine was paid by Arthur Tappan (1786-1865), in 1830, and he started the "Liberator," in Boston, January 1, 1831. His coadjutors were William Jay, Parker Pillsbury (1808), Lucy Stone (1818), Abby Kelly, Stephen S. Foster (1809-1881), Theodore Parker (1810-1860), John Pierpont (1785-1866), Lydia Maria Child (1802-1880), Owen Lovejoy (1811-1864), John G. Whittier (1807-1892), Wendell Phillips (1811-1884), Cassius M. Clay (1810), Samuel J. May (1797-1871), Joshua R. Giddings (1795-1874), B. F. Wade (1800-1878), James G. Birney (1792-1857), John P. Hale (1806-1873), Gerrit Smith (1797-1874), Thaddeus Stevens (1793-1868), Frances Wright (1795-1853), George Thomson, Theodore D. Weld (1803), Nathaniel P. Rogers, Frederick Douglas (1817-1895), Gamaliel Bailey (1807-1859), W. H. Burleigh (1812-1871), C. C. Burleigh, George Bradburn, and a noble company besides.

Among the earliest of these was Lydia Maria Childs, whose pen was fervid in its portrayal of the vice and crime of slavery. Higginson's interesting biographical sketch of this reverend woman, whom Whittier apostrophized in the words, "O woman greatly loved!" is sufficient to afford all needful knowledge of her personality. It shows that her "Appeal for that Class of Americans called Africans" was at once the cause of her ostracism and her fame. She was contemptuously set aside as an author at the South; she became honored as a reformer at the North. Among the early abolitionists she has a foremost place. Her literary fame, though great, is almost eclipsed by the sense of her philanthropic spirit. The exercise of this noble spirit caused her books to fall into sudden obscurity. She anticipated this when she wrote her "Appeal" in behalf of the poor slave. Her words had the Spartan ring and the Christian martyr tone as she said in its preface, "I am fully aware of the unpopularity of the task I have undertaken; but, though I expect ridicule and censure, I cannot fear them. A few years hence, the opinion of the world will be a matter in which I have not even the most transient interest; but this book will be abroad on its mission of humanity long after the hand that wrote it is mingling with the dust. Should it be the means of advancing the inevitable progress of truth and justice, even one single hour, I would not exchange the consciousness for all Rothchilds' wealth, or Sir Walter's fame." This was the first anti-slavery work in book form ever printed in America; and even Doctor Channing attributed a portion of his anti-slavery zeal to this book.

Rev. Calvin Fairbank (1816-1898) was one of the living martyrs of anti-slavery, whose experience illustrates the spirit of slavery and the fate of its opponents. He was one of the most noted of the famous abolitionists who conducted the "under-

ground railroad" before the war, and he suffered with the slaves, and knew what it was to feel the lash. During his lifetime Mr. Fairbank aided forty-seven slaves to escape from Virginia and Kentucky, not one of whom was ever recaptured. For this he was twice imprisoned in Kentucky, in all seventeen years and four months. He was frequently beaten by the prison overseers, and during only eight years of his last term, from March 1, 1854, to March 1, 1862, he received 35,105 stripes from a leather strap fifteen to eighteen inches long and one and a half inches wide and from one-quarter to three-eighths of an inch thick. The whipping grew out of the inability of Mr. Fairbank to perform the task assigned him. His daily task, timed by the hour, was to weave 208 yards of sacking, or 37,440 shots of the shuttle by hand. He could never weave more than 165 yards. The result was that he was whipped every day except Sunday and the Fourth of July. He was never whipped less than twice a day, and in most cases four times. The number of stripes ranged from 55 to 108, according to the whim of the overseer. Sometimes, so terrible were the lacerations of the cuts on his bare body, that the walls of the prison were spattered with flesh and blood.

Prudence Crandall (1803) deserves honorable mention. She conducted a model school in Canterbury, Connecticut, and insisted that respectable young women of color should attend. For this she was tabooed, boycotted, and persecuted, and in 1833 her school buildings were destroyed, and she was financially ruined by the Northern supporters of the institution of slavery.

"I am aware," said Garrison in the first issue of his paper, "that many object to the severity of my language; but is there not cause for such severity? I will be as harsh as truth and as uncompromising as justice. I am in earnest. I will not equivocate, I will not excuse, I will not retract a single inch, and *I will be heard.*" The first numbers of his paper were printed for him and paid for by his own and his friend Knapp's labor as compositors; but after a short time they were enabled to purchase some second-hand type and an old press, which they set up in a garret in the old Merchants' Hall. This one dingy room, which has been immortalized by James Russell Lowell, served as a printing office, living room, and bed-room for Garrison, his friend Knapp, and a small negro boy.

"In a small chamber, friendless and unseen,
Toiled o'er his types a poor unlearned young man.
The place was dark, unfurnitured, and mean,
Yet there the freedom of a race began."

The original Anti-Slavery Society in this country, organized in 1837, numbered only twelve persons. In three years there were 200 anti-slavery societies. In seven years more there were 2,000. The abolitionists applied themselves with a fiery energy to the propagation of their beliefs. They were devoured by a zeal which knew no bounds and permitted no respite. The slave

owners, reaping large and easy gains from the labor of their bondmen, met with a deep, remorseless, murderous hatred the enthusiasts who sought the ruin of their institution. Their allies in the North lent them willing and appropriate support. In Boston a mob of well-dressed citizens forcibly suppressed a meeting of female abolitionists. Philadelphia disgraced herself by riots in which negroes were slain and their houses burned down. Throughout the Northern states the meetings of abolitionists were habitually invaded and broken up, often with shameful violence. For thirty years this contest raged. It became the grand absorbing question of American politics. It evoked hatreds of unparalleled intensity and bitterness. It drew a deep line of separation between the states which owned and those which did not own slaves.

Slavery was the fatal bequest of the founders of the Republic. It was surrounded with safeguards; it had created a privileged class, in whose hands it had always been an element of power in the nation, and it was growing more and more arrogant and aggressive. In vain did a few philanthropic men try to make head against it. Slavery stood intrenched behind the constitution of the nation, and defied them. Nay more, scorn, abusive epithets, and violence were liberally meted out to this weak band of agitators, even in the free section of the Union. Garrison, Whittier, Phillips, Tappan, Birney, and their intrepid colaborers were barely tolerated at home. In the slave states no one dared to raise a voice against the iniquitous domestic institution. But "Uncle Tom's" myriad voices could not be silenced. An English writer of eminence has spoken of it as one of those books which insist upon being read when once begun. And read it was, both North and South. Slaveholders read it secretly. Resistance to the encroachments of slavery upon free territory began at this era. That resistance produced open war between the sections; war brought about emancipation; and in a little more than ten years after the appearance of "Uncle Tom" no slave was lawfully held in bondage within the vast territorial limits of the American Union. We can now look back and see how it was that Mrs. Stowe did more to bring about this result than all other agencies put together.

"Uncle Tom's Cabin, or Life Among the Lowly," was published in 1852. Its success from a literary standpoint was prodigious; and as that success is the key to its moral influence, we will give a few facts in relation to it. In a few weeks' time 50,000 copies had been sold; in a few months 200,000 had been struck off, and the demand was still for more. Within two years, it is said, 2,000,000 copies had been spread throughout America and Europe, where it was quickly translated and scattered broadcast over the continent, and thousands of pirated copies were issued besides. And notwithstanding the fact that slavery, with all its accompanying evils, has now been for thirty-five

LINCOLN AND HIS CABINET.

THE BERLIN CONGRESS.

"The leading figures in the Congress were Prince Bismarck and Lord Beaconsfield."

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ppressed race, and glorified
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country. He began his public life as a teacher, and entering the Presbyterian ministry, he also established a religious paper in St. Louis. Driven from Missouri in consequence of his abolition utterances, he shipped his plant to Alton, Illinois, where his press was three times destroyed by mobs, and where he was murdered while defending his property, a martyr to liberty. A noble monument marks his resting place, dedicated November 8, 1897, the sixtieth anniversary of his death. His last words, when summoned to abandon his purpose, or suffer the consequences, were:

"If the civil authorities refuse to protect me I must look to God, and if I die I am determined to make my grave in Alton. But, gentlemen, as long as I am an American citizen, and as long as American blood runs in my veins, I shall hold myself at liberty to speak, write and publish whatever I please upon any subject, being amenable to the laws of my country for the same."

In 1850 the Fugitive Slave Law had been passed by Congress, and it was made obligatory on all free states to return escaped fugitive slaves to bondage, but the legislation so outraged the lovers of freedom that it intensified the opposition to slavery, and hastened the day of emancipation. It seemed that the hour was never darker for the slave, and that his chains were never more securely riveted than on January 1, 1861; and yet on the 13th of April a gun was fired in the harbor of Charleston, South Carolina, whose reverberations were to continue until the last

manacle was broken. For the war demonstrated the fact that the freedom of the slave must be pronounced before the Union armies could succeed in subduing the rebellion, and accordingly on January 1, 1863, appeared the proclamation issued by President Abraham Lincoln, declaring the negro slaves within the boundaries of the United States free. There were two documents of this nature issued by the President, one (the preliminary) being given to the public on September 22, 1862, the provisions of which were to take effect on January 1, 1863. On this latter date, the success of the Union armies seeming to warrant such a course, he issued the final proclamation, in which he designated ten states, or parts of states, as being in a state of rebellion against the Union, and decreed that in the territory so designated slavery was forever abolished. Although there had been a tacit acquiescence to this proposition, it was not until two years has passed that Congress gave its assent to a measure to put the matter before the country. To this end, on January 31, 1865, two months before the collapse of the Confederacy, Congress, by joint resolution, passed the thirteenth amendment, and ordered that it be submitted to the states for ratification. Before the end of the year twenty-seven out of thirty-six states—more than the required two-thirds—had ratified the amendment.

Thus after thirty years of conflict the edict was given that the nation that would not obey the dictates of justice peacefully proclaimed, should listen to the command from the thunder-cloud of war, and it was not until its dread horrors had smitten every home that "Slavery with all its reeking, shrieking altars and ghastly paraphernalia of whips, fetters, blood-hounds, and red-hot branding irons was swept away in cataclysms of blood and fire."

Following the example of other civilized nations Dom Pedro, in 1888, emancipated slavery in Brazil.

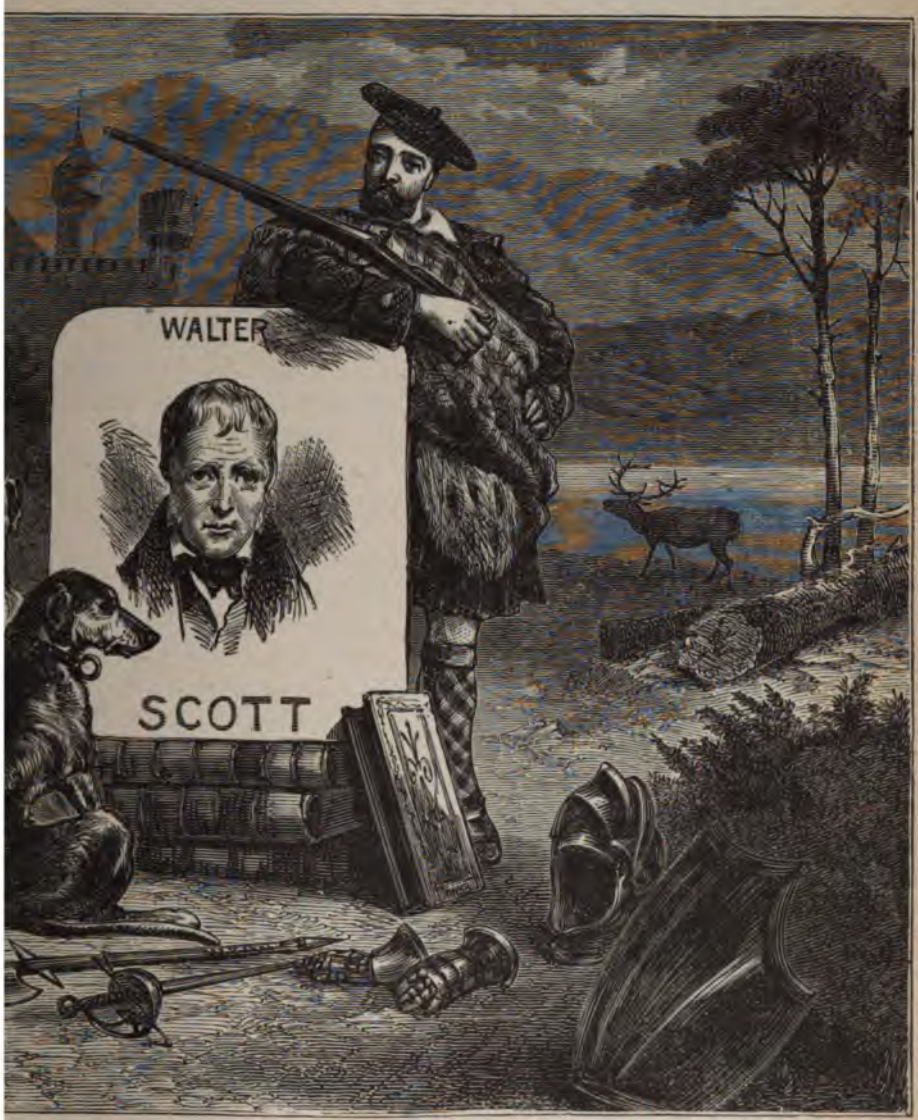
It was not until December 14, 1888, that the German Reichstag suppressed the slave trade in its East Africa dominions.

At the beginning of the century Russia was little better than a nation of barbarians. When this century was half gone, 48,000,000 peasants were bought and sold like slaves. As early as 1830 Czar Nicholas contemplated emancipation, and when dying bequeathed his intention to his son, Alexander, who, on his accession to the throne, announced his purpose to emancipate the bondmen, which purpose was fulfilled February 19, 1861, when the decree was published, and March, 1863, when the act was completed, which bestowed freedom upon nearly 50,000,000 peasants, by Czar Alexander II (1818-1881).

The first successful African slave-trader, John Hawkins, was knighted by Queen Elizabeth. The last was hanged in New Orleans, in 1861. What centuries of progress in 300 years! Thus it may truthfully be said that the most gigantic evil that was ever reared on earth was first systematically assailed, and finally extirpated in the present century.

WALTER SCOTT.

[Born 1771. Died 1832.]



was not until 1814 that the appearance of "Waverley" marked an event in the era of literature. ıg after the weak, fashionable novel of the period, its free, graceful, natural, and manly style d a deep sensation. As is well known, it was published anonymously; and for some years after- "By the author of 'Waverley'" was on the title page of his novels. He produced them with shing rapidity,—as many as six or seven volumes annually; and the even greatness of the talent yed in them is simply marvelous, let alone the grandeur of the construction and the dramatic of the characters.

CHAPTER XLIII.

ARBITRATION.

DISPOSITION TO AVOID WAR—GREAT SUBJECTS ARBITRATED—THE T—THE ALABAMA—BEHRING SEA—NEW ORLEANS ITALIANS KILLED— —THE RUSSIAN CZAR'S EFFORTS IN 1899.

EN the century opened all Europe was convulsed with war, and in its early years country was paralyzed by ith England. Of the 170,- inhabitants of Europe, were engaged in the work ction, and the energies of ere absorbed in sustaining s, and repairing the ravages troyers. Poverty, sorrow, re in almost every home. rter of a century, including fteen years of the present, iversal conflict wasted Eur- want and woe created such n as has never since pre- Before the conflict closed f property and thousands ad been sacrificed.

e formation of the federal n the United States has four years and a half of r international warfare, hin the same period our nt has been a party to n arbitrations, more than l that have taken place in n world.

Victoria Alexandria, of (1819—), when visiting 1855, sounded the interna- y-note of the Nineteenth Century, when in the Invalides, she stood at the sepulcher of the great Napoleon. In her biography occurs this significant passage: "I stood at the arm of Napoleon III, his nephew, before the coffin of England's bitterest foe. I, the granddaughter of that king who hated him most and who most vigorously opposed him, and this very nephew who bears his name being my nearest and dearest ally, the organ of the church playing 'God save the Queen' at the time. Strange and wonderful, indeed. It seems as if in this tribute of respect to a departed dead foe old enmities and rivalries were wiped out and the seal of heaven placed upon that bond of unity which is now happily established between two great and powerful nations. May heaven bless and prosper it."

One of the most hopeful of all modern movements is the substitution of international arbitration in place of war. Instead of settling international differences as has always been done by the arbitrament of the sword, there is a growing sentiment in favor of submitting the decision to a mutually chosen tribunal. To this end peace congresses have been held,

and peace societies have been organized throughout the civilized world. Early in the century there were peace societies formed, and later peace congresses were held in London, Frankfort, Brussels, Geneva, Paris, etc., to discuss the principle and suggest plans. (The compiler of this volume was a delegate to the World's Peace Congress, in 1850, at Frankfort-on-the-Main.)

Already the doctrine of arbitration has been applied, in the case of Luxembourg, in 1867; Crete, in 1869, and notably in the case of the Alabama.

Since 1818, when the conference was held at Aix-la-Chapelle, the Christian nations have been maturing a growing sentiment against war, and in favor of adjusting all international differences through mutual councils, and thus putting an end to war. The movement is another illustration of the progress achieved in the present century.

The principle of arbitration instead of war has been fairly tested under most critical circumstances, and has triumphed, as it is safe to say it would not have done before the advent of the Nineteenth Century.

In the earlier days of the great war of secession, on the eighth of November, 1861, Captain Charles Wilkes (1801-1877), of the "San Jacinto," an American man-of-war, stopped the British mail steamer "Trent" a short distance from Havana by the summary process of firing first a round shot and then a shell across her bows. Captain Wilkes had been ordered to arrest Messrs. J. M. Mason (1798-1871), and John Slidell (1793-1871), who were on board the "Trent." Mr. Mason was accredited by the Confederate government to the English court, Mr. Slidell to the Court of France. They had run the blockade from Charleston to Cuba, and were now on their way to Europe. After a vigorous protest on the part of the captain of the mail steamer, the Confederate envoys surrendered, and were carried off by Captain Wilkes. No doubt the act was unjustifiable, and a proper justification of war, as nations usually act. For a moment all Britain rang with clamor and clangor of preparations for war. Lord Palmerston was then Prime Minister, a man ever inclined to mount the high horse and "stand no nonsense." The case was clear. The law officers of the Crown advised the Cabinet that there could be no doubt whatever as to the merits of the question, but a courteous correspondence ensued between Lord Granville and Secretary Seward, and a peaceful adjustment resulted.

The case of the "Alabama" is a complete vindication of arbitration. England permitted her ships to prey upon American commerce. The time came for America to sum up her losses, and call upon England to indemnify her. England proposed arbitration, but America, too angry as yet, rejected the proposal. A few years passed, more temperate counsels prevailed; the offer was renewed, and accepted in 1871. Commissioners were chosen, to whom America submitted her claims. The judges found that reason was upon her side, and ordained that England

pay £3,000,000 sterling as
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d," was seized for violating
of Congress making it a pen-
catch seals within the waters
ng sea; and the United States
Court of Alaska declared a
re of the vessel. This, how-
d not put a stop to the catch-
the seals by the British, and
ble went on. This reckless
of the seals, and the ignoring
ights of the United States to
ne broad jurisdiction in the
as England had conceded to
led to a protest on the part
United States—a protest so
firm and vigorous as to cause an interchange of very clever diplomatic dispatches. When it is remembered that James G. Blaine had charge of affairs in our behalf, we can realize that our rights were well protected. Lord Salisbury had, on behalf of England, offered arbitration, which Mr. Blaine rejected as unsatisfactory in form. Many alarming rumors arose at this time; among them, that a large part of the United States naval force was under orders to proceed to the disputed waters for the protection of American interests.

The difference of opinion was in relation to the rights of the United States as to the limits of the ocean. Mr. Blaine contended that the United States had by purchase acquired all the privileges, rights, and franchises which had belonged to Russia. Lord Salisbury, on the contrary, held that the three-mile limit should be observed. Mr. Blaine then invited an offer of arbitration on the real questions at issue, which were as follows: (1) What exclusive jurisdiction in Bering sea did Russia have previous to the purchase of Alaska by the United States? (2) How far did Great Britain recognize these claims as to the seal fisheries? (3) Was what is known as Bering Sea included in the phrase, Pacific Ocean, in the treaty of 1825? and what rights, if any, were given to Great Britain by that treaty? (4) Did not all the rights of Russia in the fisheries east of the water boundary pass to the United States by the treaty of March 30, 1867? (5) Has the United States any right of property in the

fur seals, outside the ordinary three-mile territorial limits? (6) How far outside the ordinary limits should the United States have exclusive jurisdiction to protect the seal, living and feeding on the United States islands, and if so, when? The Board of Arbitrators sat in Paris, France. The following decision of the tribunal was made public August 15, 1893, in Paris:

"By the ukase of 1821 Russia claimed jurisdiction in the sea now known as Bering sea to the extent of 100 Italian miles from the coasts and islands belonging to her, but in the course of the negotiations which led to the conclusion of the treaty of 1824 with the United States, and the treaty of 1825 with Great Britain, Russia admitted that her jurisdiction in said sea should be restricted so as to reach a cannon shot from shore. It appears that from that time up to the time of the cession of Alaska to the United States, Russia never asserted in fact nor exercised any exclusive jurisdiction in Bering sea, or any exclusive rights to the seal fisheries therein, beyond the ordinary limit of territorial waters.

"As to the second of the five points, we decide and determine that Great Britain did not recognize or concede any claim upon the part of Russia to exclusive jurisdiction as to the seal fisheries in Bering sea, outside the ordinary territorial waters.

"As to the third point, as to so much thereof as requires us to decide whether the body of water now known as Bering sea was included in the phrase 'Pacific Ocean,' as used in the treaty of 1825 between Great Britain and Russia, we unanimously decide and determine that the body of water now known as Bering sea was included in the phrase 'Pacific Ocean,' as used in said treaty.

"On the fourth point, we decide and determine that all the rights of Russia to jurisdiction and to the seal fisheries passed to the United States, limited by the cession.

"On the fifth point, we decide and determine that the United States have no right to the protection of or property in the seals frequenting the islands of the United States in Bering sea, when the same are found outside the ordinary three-mile limit."

An illustration of the disposition to settle international troubles peacefully was seen in the year 1891. On March 15th, eleven Italians were massacred in the New Orleans jail. They were accused of murdering the chief of police. After a long correspondence between the authorities of Italy and of this country, during which the American minister left Rome and the Italian minister left Washington, the American government placed $25,000 in the hands of the Italian charge d'affaires, at Washington, to be distributed among the heirs of three of the Italians killed, who were Italian citizens. In almost any preceding age the incident would have been *casus belli*.

A similar occurrence was with Chile. On October 16, 1891, several sailors of the United States steamship Baltimore, then in the harbor of Valparaiso, were attacked by a mob of 2,000, and eighteen were

stabbed or beaten. President Harrison acted with great promptness, and on January 21, 1892, demanded an apology for the assault, and indemnity to the sailors injured, and to the families of those killed. Seventy-five thousand dollars was paid by Chile, and distributed to the wounded, and to the heirs of the sailors killed.

Since Noah Webster, the great lexicographer, founded the American Peace Society, in 1817, the disposition to avoid war, except in the last extremity has increased among the American people, and "Arbitration instead of War" may be said to be one of the watchwords of the Nineteenth Century.

Among the promoters of peace should be mentioned William Ladd (1778-1841), "the apostle of peace," and Elihu Burritt, "the learned blacksmith" (1810-1879), who, at the age of twenty-seven, could read about fifty languages.

In 1898, when Spain and the United States were on the verge of war, the six leading nations of Europe joined in a friendly expostulation with the contending parties, against the impending war. This action was without a parallel in history; it was the first and the only time that the six great nations of Europe, representing in the aggregate, the power of civilization, had united in this solemn manner to secure the peace of the world.

The war with Spain exhibited a higher tone of humanity than was ever seen in war before; the burial of Spanish sailors by the Americans with the honors of war; Captain Evans' refusal to accept the sword of Cervera; Captain Philip's "Don't cheer, boys, the poor fellows are dying;" and other incidents, cast a gleam of light across the dark cloud of war. No war between nations ever before exhibited such humanity. The spectacle of a victorious nation sending home, at its own expense, the defeated army of the vanquished is one that challenges the admiration of the world. It is without precedent in the annals of human warfare; it has no parallel in the compacts of peace.

In the year 1898 opened a new era to the civilized world. A great, conscious step forward was made in the development of the race. England and the United States clasped hands as never before in the history of nations because one ideal shines before them both. The much talked of Anglo-American alliance is but the beginning of the ever growing alliance among nations that feel the responsibility of superior growth and development.

In the year 1898 the Czar of Russia, Alexander III (1845), proposed international disarmament, and the growing sentiment of the civilized nations is toward arbitration instead of war in the settlement of national differences. In 1899, Queen Victoria, in a speech from the throne, responded to the fraternal words of the Czar, and as we close this book a Peace conference, looking toward universal disarmament and arbitration is being held at the Hague, by representatives of all the great civilized nations. It would not be strange if the dawn of uni-

versal peace should break while the nations are rivaling one another in preparations for war—just as emancipation came in a moment when slavery seemed intrenched for perpetuity.

Professor Moore has shown that there was the Jay arbitration, which fixed our northeastern boundary in the early days of the Republic; the treaty of Ghent, with its arbitration of our northern line along the great lakes; and the northwestern boundary; the famous Genevan tribunal, concerning the Alabama claims; the arbitrament of the Washington treaty, concerning the Canadian fisheries; these are but four of the seventeen disputes between England and the United States which have been settled by arbitration. Nineteen times have we been in serious difficulty with England; twice have we gone to war; seventeen times our disputes have been peacefully settled by arbitration. We have also arbitrated misunderstandings with Brazil, Chile, Colombia, Costa Rica, Denmark, Ecuador, France, Hayti, Mexico, Paraguay, Peru, Portugal, Spain and Venezuela. We have, therefore, submitted forty-nine international disputes to arbitration. We have had but three foreign wars since the nation was formed. Without arbitration, we should have had fifty-two. The world is hastening to establish a Supreme Court of Arbitration, to settle all international difficulties without war.

ROBERT SOUTHEY.

[Born 1774. Died 1843.]

"If biography be not utterly worthless, these illustrations of his character have an inestimable
e. Look at him, pen in hand, the indefatigable laborer in his literary seclusion, with no inheri-
e but a vigorous intellect, no revenue but such as his industry might furnish, perfect in the rela-
of husband, brother, father, friend; by his chosen labors delighting the world, as well as minister-
to the happiness of his needy circle. Look, we say, and confess that heroism is here which
uerors might envy."

CHAPTER XLIV.

FOREIGN MISSIONS.

ESE GREAT AGENCIES, ALL THE WORK OF THE NINETEENTH CENT-
ONS CONVERTED — JUDSON — HARRIET NEWELL — GREAT GLORY
NTURY.

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ssionary movements
eralds into all the cor-
arth. Colleges were established for the training of missionaries. A vast network of auxiliaries for the collection of funds overspread Protestant Christendom. The Bible was translated into many languages hitherto unwritten; grammars and dictionaries presented to the learner the simple structure of these rude tongues. Teachers of the Gospel were to be found here and there in heathen lands, facing with heroic courage the dangers of the Christian pioneer, bearing with brave fortitude his inevitable and often fatal hardships. Among the snows of Labrador, under the fierce heat of the tropics, in the East Indies, among the Hottentots at the Cape, in the islands of the Pacific, among the negroes in the West Indies, men had begun in simple faith, with means conspicuously inadequate, the gigantic work of driving out heathenism and replacing it by Christianity. A little later, China was entered by the door which the English opened in their determination to force the use of opium on that empire. A few missionaries found their way into Japan. Dotted along the western shores of Africa, and seeking their way into the interior, are numerous mission stations, each the center of a benign influence

which is steadily extending its power, and preparing the restoration of that lost continent to civilization and progress. The sum of these efforts, viewed in relation to the vast proportions of the undertaking, is still inconsiderable. Great Britain sends out 1,000 missionaries, and expends annually $3,000,000. The Continental churches employ 400 missionaries, at a cost of $700,000. America contributes 550 men, and $1,500,000. In all there are now at work in heathen countries 2,000 Protestant missionaries, and the churches sustain the work by an annual contribution of about one million sterling."

The Roman Catholic Church, always active in this work, employs as much money, and as many men, as do the Protestants.

One of the most striking of the many object-lessons to which the foreign missionary may point, is the Sandwich Islands. During the century the people of that archipelago have progressed from the lowest condition of savagery to comparative civilization. The islands were discovered by Captain James Cook (1728-1779), who was murdered there. It is an earthly paradise, but when discovered the inhabitants were among the lowest of human beings. They lived like animals, without modesty or shame. The Hawaiian of olden times beat his clothing out of the bark of the mulberry tree, or plucked it, feather by feather, from great numbers of small birds. Poi; raw or half-cooked fish, snails and other outlandish pick-ups constituted much of his food, and his views on the relations of the sexes would have overpowered the comprehensions of even Brigham Young, of polygamous memory. He had many gods, and a system of tabu which made it death for him, among other things, to eat a banana, light a fire, utter a sound, or come within the shadow of the king's house at certain times. He was the victim of a terrible institution of sorcery, and at certain of his religious ceremonies, human sacrifices were offered up, and an eye of the corpse was plucked out and eaten by the person who for the time being represented the god, whence arose the belief that all Hawaiians were cannibals. He rode great ocean breakers on a board, or leaped from precipices into a sea where lurked the man-eating shark, and he had other games equally careless of human life, including boxing matches, in which it was not uncommon for one champion to leave several men dead in the arena, at one time. Also he played at war; and to this day the spot is visited by all tourists, where a routed army was driven over a precipice to destruction, while its chief later became a sacrifice to his conqueror's war-god. The Hawaiian of a hundred years ago was a prey to imported diseases and vices, brought by Botany Bay convicts and equally unscrupulous traders, and, capping the climax of his unhappy condition, foreign aggression menaced his very racial existence. It was at this time, when the islands were ripe for the ministrations of the servants of the cross, that a pioneer company of American missionaries arrived at

and took up the noble work liorating the sufferings of the an people. The commence- of the American Protestant in the islands was the turn- nt for Hawaii. Its belief in anity, its intelligence, refine- and wealth, as displayed in merous churches, splendid , comfortable and even ele- mes, and great business en- s; the liberties of the people range as it may seem, the istence of the throne itself, 893, are all due to the heroic of God-fearing Americans eir successors and descend-

s in 1819 that Christian mis- s landed; introduced educa- ivilization, the teachings of istian religion; built schools rches, and in a few years the population was under the ce of the Christian religion, twenty years Christianity was epted religion of the nation, fifty years it was decided that dwich Islands were no longer ary ground. The mission sed, having cost less than 000 from first to last. The aries taught how to cultivate ton plant, and how to spin ave its fiber. They taught extract sugar from the cane. nstructed a docile people in cencies and comforts of civ- life. Roads were made; were built; a newspaper ablished; industry prospered nid the seductions of idleness a tropical climate presents. ands took a respectable place in the records of commerce. In 1867 the imports were $2,000,000; the exports—consisting of sugar, coffee, arrowroot, timber, beef, and hides—amounted to $2,500,000, and were steadily increasing. The government expenditure was $500,000. Even that crowning evidence of civilization, a national debt, was not wanting. The country had borrowed $125,000 to promote the development of its resources. No such progress has ever been achieved by any people as the Sandwich Islanders wrought during a half century under the lead of the Christian missionaries. Heathenism had utterly disappeared from the islands; Christianity had come in its stead, bringing in its train security to life and property, peace, industry, and progress; raising the wasteful and treacherous savage to the dignity of a God-fearing, law-abiding citizen, who bears fairly his part in contributing to the common welfare of the human family.

John Henry Barrows, D. D., of Chicago, after visiting most of the lands in which Christian missionaries had labored, said in October, 1897: "If I were asked to name that place which I have seen in all the world where Christian civilization, as shown in general intelligence and morality and good will among different races, in the abundance of schools, asylums and churches, in widespread material prosperity, and in zealous devotion to the expansion of God's kingdom on earth had reached its brightest manifestations, I should mention without a moment's hesitancy a tiny state in the

Pacific, which Congregational missions lifted out of savagery, and which may before long be linked to the American commonwealth—the island republic of Hawaii."

Similar progress has been achieved in South Africa. One of the fiercest of the races, the Bechuanas, without a trace of religion, and vicious to the last degree, have been transformed into a comparatively orderly, industrious and Christian people, since Moffat began his heroic and consecrated labors among them.

Results the same in kind, if not in degree, are seen in India, China, Japan, Africa, the remotest islands of the sea, and wherever the Christian missionary has gone. Education, industry, morality, religion have blest the people, sometimes almost "a nation in a day." And the blessed work had all been achieved during "the century of centuries, the Nineteenth Century."

There are many different English organizations at work in India, to propagate the Gospel among the millions of that populous land. There are more than 600 foreign missionaries there, besides native converts, and millions of copies of the Bible and other books have been circulated within the last few years. The American Board of Foreign Missions was organized in 1810, and has already expended from $20,000,000 to $30,000,000 to elevate the heathen races.

His Excellency, Li Hung Chang, Viceroy of China, gives this testimony to the character of American missionaries in China, who, he says (1897), "Have not sought for pecuniary gain at the hands of our people. They have not been secret emissaries of diplomatic schemes. Their labors have no political significance, and last, not least, if I might be permitted to add, they have not interfered with or usurped the rights of territorial authorities. From a philosophical point of view, as far as I have been enabled to appreciate, Christianity does not differ much from Confucianism, as the golden rule is expressed in a positive form in one, while it is expressed in a negative form in the other. Logically speaking, whether these two forms of expressing the same truth cover exactly the same ground or not, I leave to the investigations of those who have more philosophical tastes. It is, at the present, enough to conclude, there exists not much difference between the wise sayings of the two greatest teachers, on the foundations of which the whole structure of the two systems of morality is built. As man is composed of soul, intellect and body, I highly appreciate that the missionary boards in their arduous and much-esteemed work in the field of China, have neglected none of the three. I need not say much about the first, being an unknowable mystery of which our great Confucius only had an active knowledge. As for intellect, they have started numerous educational establishments, which have served as the best means to enable our countrymen to acquire a fair knowledge of the modern arts and sciences of the West. As for the material part of our constitution, these societies have started hospitals

INDIAN TYPES.

"The Red Man of a hundred years ago is a curiosity to-day."

SENATE READING-ROOM IN CONGRESSIONAL LIBRARY.

"The progress of education in America is one of the great triumphs of the century."

and dispensaries, to save not only the soul, but also the body of our countrymen. I have also to add that in the time of famine in some of our provinces they did their best, to the greatest number of the sufferers, to keep their bodies and souls together. Opium smoking being a great curse to the Chinese population, American missionaries have tried their best, not only as anti-opium societies, but to afford the best means to stop the craving for the drug."

The missionary societies of the "Evangelical" churches of the United States, Canada, Great Britain, continental Europe, Asia, Africa and Australia number more than 250, with 5,000 stations and 20,000 out-stations. There are 12,000 missionaries, 65,000 native laborers, and 1,500,000 communicants. There are 1,000,000 persons under instructions, and the income in all these countries is $14,000,000. Besides these are the missions of the non-Evangelical churches, such as the Unitarian and the Universalist denominations. The missions of the Catholic Church among the heathen and non-Christian nations are older than the Protestant, and very numerous. The Jesuits have labored with wonderful success among the aborigines of both continents. There are nearly a thousand Catholic missionaries in China alone, with 750,000 converts.

Among the earlier missionaries to foreign lands are Adonira Judson (1788-1850), and Mesdames Judson, Ann H. (1789-1826), and Emily C. Fanny Forester (1817-1854), Sarah Hall Boardman (1803 - 1845), F. Mason (1790-1874), Harriet Newell (1793-1823), Geo. D. Boardman (1801-1831), J. A. Dubois (1765-1848), J. Heckewelder (1743-1823), E. R. Huc (1813-1860), Alexander Duff (1806-1878), Wm. Yates (1792-1845), M. Winslow (1789-1864), Justin Perkins (1805-1869), Samuel Nott, Joseph Wolff, Samuel Newell (1784-1821), Gordon Hall (1782-1826), Robt. Moffatt (1795-1883), Wm. Carey (1761-1834), Bishop George A. Selwyn (1809-1878). These and a noble army of less distinguished soldiers of the cross, are inscribed in the muster-rolls of the Prince of Peace as heroes who have wrought the highest triumphs.

May it not be believed that the magnificent work of the seventy-five years just ending is but the prelude of the years to come, when Christianity shall be the religion of the world, and He whose right it is to reign shall indeed be the "King of kings and Lord of lords."

Our minister to China, Honorable Charles Denby, truthfully says: "Missionaries are the pioneers of trade and commerce. Civilization, learning, instruction breed new wants, which commerce supplies. Look at the electric telegraph, now in every province of China but one; look at the steamships which ply along the coast from Hongkong to Newchwang, and on the Yang-tse up to Ichang. Look at the cities which have sprung up, like Shanghai, Tientsin, Hankow—handsome foreign cities, object lessons to the Chinese. Look at the railroad being now built from the Yellow Sea to the Amoor, of which 200 miles are

completed. Will any one say that the 1,500 missionaries in China, of Protestants, and perhaps more of Catholics, have not contributed to these results? The missionary, inspired by holy zeal, goes everywhere, and by degrees foreign commerce and trade follow. I suppose that whenever an uncivilized or semi-civilized country becomes civilized, its trade with Western nations increases. Humanity has not devised any better, or even as good, engine or means for civilizing savage people as proselytism to Christianity. The history of the world attests this fact."

Among the glories of the century none is greater than this. All other enterprises of beneficence must yield to this magnificent attempt to expel debasing superstitions, and convey into every heart the ennobling influences of the Christian religion. In the priceless results already gained, we discover warrant to expect that in some not very remote future the missionary will fulfill his daring and glorious programme—the Christianizing of the whole world.

"Within twenty years," wrote Charles Darwin, in his Voyage of a Naturalist, Around the World, "human sacrifices, the power of an idolatrous priesthood, profligacy unparalleled in any other part of the world, infanticide, bloody wars not sparing women and children . . . all these have been abolished. Dishonesty, intemperance, licentiousness, have been greatly reduced by the introduction of Christianity."

Carey tells us that when he went to work in India in 1793, twelve or thirteen pilgrimages were made every year to the famous Juggernaut (or Juganath) in Orissa, and that not less than 120,000 human beings perished annually from immolation, want, fatigue, fevers, and other diseases; and do we not know that to all this misery an end has been put by his and his successors' self-denying labors? Sixty years ago the Fiji Islands were peopled by a race of ferocious cannibals, to whom not a ray of light from the Christian world had penetrated. In 1858 the Wesleyan Society of England began laboring for the conversion of these pagans; and what is the result? The fierce islanders are Christianized,—100,000 out of a population of 125,000 having become Wesleyans; and among the recent contributions to the London Mansion House Fund for famine relief in India, is one of over $4,200 from these converts.

Think of 250 languages, mastered by the apostles of Christianity, and reduced from spoken to written tongues! Think of the many dictionaries compiled, translations of the Bible made, and the vast and invaluable fund of material contributed to the science of Comparative Philology! Trade and commerce are indebted to the missionaries for new channels opened. Without any diminution of energy in their spiritual work, "they have collected valuable data of all kinds bearing on the study of man, and the effect upon him of climate, food, and environment. Scores of instances might be named where missionaries became industrial as well as spiritual teachers, and sowed among savage nations the seeds of civilization."

CHARLES DICKENS.

[Born 1812. Died 1870.]

he question, therefore, whether it would be justifiable to turn his great gifts to mere purposes of ement was one likely to impress the active and benevolent mind of Dickens. That he did from y early period of his career seek in this way to combat evil and to encourage good,—and above awaken that sympathy with the weak and helpless which is the first condition of resolute effort eir benefit,—is clear to all readers of his writings; nor should it ever be forgotten that as the r of stories "with a purpose" in this sense, he was absolutely the creator of a new kind of fiction.

CHAPTER XLV.

ALTRUISM.

SOCIAL MOVEMENTS—FOURIERISM—BROOK FARM—ROBERT OWEN—Y. M. A.—Y. P. C. U.—CHRISTIAN ENDEAVOR—SUNDAY SCHOOLS—IMPROVENTS OF INDIANS, ETC.

ERE are multitudes of movenents all through Christendom npelled by the growing altrumankind. "Altruism" is a nvented by Auguste Comte 57) and warmly adopted by t Spencer, to express the sis of Egoism. Literally the gnifies other people's good, welfare of others. Altruist, Triumphant, Bruderhof Menand the societies known by nes Amana, Harmony, New and Adonai Shomo illustrate dency. For many years the Community in New York n a noted institution, and endegree of prosperity unusual bodies. Communism of a cerdified type was advocated in ritain by Robert Owen (1771- his "New View of Society," ed in 1813. He attempted the assistance of any governfound a society on the new n the banks of the Wabash, , but the attempt failed. nought it would be multiplied ciety should be revolutionized. bubble burst in five years, more was heard of it. A secablishment, fixed in 1827, at n, on the parish of Bothwell, arkshire, Scotland, was also unsuccessful as was a third, called "Harmony Hall," commenced in 1843, in Hampshire, England. These attempts, however, tended to bring the subject of co-operation into public notice. Communism had taken deeper root on the Continent than in Great Britain. C. H. Simon (1760-1825), Fourier, and P. J. Proudhon (1809-1865) have been its leaders in France, and it seems working as a great unseen force in Germany and Russia. But no European Communistic society has yet been successful, though in many cases co-operative schemes have achieved the end designed by their founders.

Fourierism originated with Charles Fourier (1772-1837). He was a benevolent man, who attempted to devise a scheme for the benefit of society, and in a series of publications made known the opinions since called by his name. He was a devout but liberal Roman Catholic, and believed that he was acting in conformity with Scripture principles in proposing his scheme. His society was called from the word phalanx, a phalanstery, consisting of about 400 families, or 1,800 persons, who should live together, combining their labor, upon a district about a square league

in extent. The buying and selling transactions requisite for the support of the community, were to be managed by a single person, which would save a multitude of peddling operations. If any brought capital into the concern, it was not confiscated, but he was allowed interest upon it. The labor being carried on in common, the profits were apportioned on the following system: First a minimum of mere subsistence money was assigned to every member of the society, including those incapable of labor. The remainder of the profits were then divided, in proportions agreed on beforehand, to remunerate labor and talent, and pay interest on the capital received. The profits divided thus were then expended by the individual recipients as they pleased. Fourierism is one of the plants of the present century, that has borne no fruit. Fourierism acquired thousands of acres of land, and hundreds of people were organized into many phalanxes, but all failed.

One of the attempts at materializing Fourierism was made in Brook Farm, Roxbury, Mass., in 1841, by a coterie of brilliant men, afterwards distinguished. William Henry Channing (1870-1884), Ralph Waldo Emerson (1803-1882), George William Curtis (1824-1892), Nathaniel Hawthorne (1804-1864), A. Bronson Alcott (1799-1888), and others. They were all transcendental enthusiasts, and their experiment was a foredoomed failure.

The century has been distinguished by attempts to materialize the doctrines of Christianity, and reduce them to actual practice. It would be well-nigh impossible to record all the organizations for human improvement that have grown up under the genial and fostering influence of the present century.

The Young Men's Christian Association was formed in London, England, June 6, 1844, the founder being Mr. George Williams. It had for its original object the holding of religious meetings in houses of business in the center of London. Many similar associations springing up and becoming affiliated together, a General Conference of Delegates from the Associations of Europe and America was held in Paris in August, 1855, and the following basis of alliance was agreed to: "The Young Men's Christian Association seek to unite those young men, who, regarding the Lord Jesus Christ as their God and Savior, according to the Holy Scriptures, desire to be His disciples in their doctrine and in their life, and to associate their efforts for the extension of His kingdom among young men." No antagonism is extended toward the churches; on the contrary, these associations "consider it alike their privilege and their duty to lead young men into the fellowship of the churches and under the influence of the Christian ministry."

Young People's Society of Christian Endeavor: The first society of the Christian Endeavor was formed February 2, 1881, in the Williston Church, Portland, Maine, by Rev. F. E. Clark, pastor, for the purpose of training a large number of con-

verts for the duties of church membership. Each society is in some local church, and in no sense outside. It exists simply to make the young people loyal and efficient members of the church of Christ. It is the church training the young. Its motto is: "For Christ and the Church." September 15, 1893, there were 27,841 societies with a membership of 1,650,000, chiefly in the United States and Canada, and in Australia, Great Britain, and in all missionary lands.

Young Women's Christian Association: A woman's religious society designed to afford to women benefits similar to those conferred on the other sex by the Young Men's Christian Association. It was founded in 1857 by the Dowager Lady Kinnaird, and has branches all over the world.

Young People's Christian Union is similar in character to the foregoing, but consists of the young people of the Universalist or Unitarian denominations. Besides these are the King's Daughters, the Epworth League, and the Brotherhood of St. Andrew, and multitudes of local organizations that aim at the conversion and elevation of mankind.

Brotherhood of Christian Unity: As the outgrowth of the Religious Parliament of the World, at the Columbian Exposition, held in Chicago, in 1893, the Brotherhood of Christian Unity was established. Its purpose was declared to be union with all those who desire to serve God and their fellowmen under the inspiration of the life and teachings of Jesus Christ.

Kindness to animals has always been manifested by some of the noblest men and women, but it was not until late in this century that an organization was formed for their protection. George T. Angell (1823) founded and was the first President of "The American Humane Education Society," and of "The Massachusetts Society for the Prevention of Cruelty to Animals," in which work he was aided by Henry Bergh (1823-1888). In 1868 he relinquished a successful law practice to devote himself to humane work. He helped establish the first "Band of Mercy," and in 1896 there were 25,000 bands, with a membership of nearly 2,000,000 persons pledged "to try to be kind to all living creatures, and try to protect them from cruel usage." "Docking" horses, cruelty in transporting animals to market, bird-shooting for mere sport or ornament, and other kinds of barbarity, have been greatly abridged within a few years, and penalties for over-loading and over-driving, and any form of ill-treatment of dumb creatures are established by law. Drinking fountains are multiplied for horses and dogs, and homes and refuges for other animls. The gospel of kindness to all creatures—"Do unto it as you would have it do unto you,"—"Put yourself in its place," is fast becoming one of the forms of the religion of the Nineteenth Century.

The "Audubon Societies," for the protection of birds, are numbered all over the United States.

SUNDAY-SCHOOLS.—One of the greatest agencies in the promotion of morality, virtue, and religion throughout the Christian world is the

Sunday-school. It originated in the thoughtful mind and kind heart of Robert Raikes (1735-1811). His teachers and pupils now number millions in all churches, and the amount of good resulting from the instruction imparted is incalculable. Practically, at the beginning of this century, there were no Christian Sunday-schools. Pounds's schools were mere refuges for children, in which they were kept from mischief and taught secular knowledge. In 1900 there are more than 20,000,000 of the young in these nurseries of religion.

IMPROVEMENT OF INDIANS. —There are schools, established within a few years by the American government, and by Catholic and Protestant Christians, to educate Indian youth. In these schools all the appliances of a thrifty and busy life are at hand. Kitchens and dormitories, most beautifully kept; neat tables, supplied with wholesome and well-cooked food, all the domestic work performed by these girls from all the Western Indian tribes—this is the surprise which awaits those who will visit the government schools. Most delicate and beautiful needle work and well-fitting clothing are the products of the sewing rooms, where, under a skilful teacher, they learn the use of the sewing machine and spend happy days. The Western schools, established and supported by the government, are most of them in Kansas, Oklahoma, California, and Indian Territory. These are mixed schools, and in every sense industrial schools. Shops for the carrying on of every kind of manual labor are provided for the boys.

The arrangement which the government has recently made with the various tribes for the opening up of their lands for settlement, will go far toward the civilization of the young people. For twenty-five years the government will extend to them its support. At the end of that time it is expected that, from their intercourse with white people, and their school education, they will have become self-supporting. It is hoped that at the end of a girl's school life she may go home to a house instead of a tent; to a permanent residence instead of a nomadic gypsy life; to a family clothed instead of blanketed; to a father and brothers who will serve her instead of exacting servitude. In the past, the years of study and training have been almost lost as the girl returns to the untidy tent upon the bleak and barren ground. What hope is there for her to maintain the tidy and systematic method which she has learned, when surrounded by the sights and sounds and blood-thirsty ways of an Otoe or a Ponca camp? But, surrounded by whites, and encouraged and taught by their teachers and native preachers, surely a bright future is before these poor Indian girls. Surely the dormant mind will awaken, and the sluggish energies quicken when she sees around her the homes of intelligent white women. The education of the Indian girl means the uplifting of the tribes in every way, and yet it means also and soon, the losing of the races of red men from off the face of the earth.

GEORGE WILLIAM CHILDS.

[Born 1829. Died 1894.]

He was a most profound believer in giving that which would contribute to self-support. An education, a start in life, he considered a better gift than money. In all, he educated about four hundred girls and as many boys. He usually promised a fixed sum for a term of years, and, wherever he could, he insisted upon the co-operation of parents. He expected an education to end early and bread-winning to begin promptly; therefore, his choice was a technical education for boys and girls, although he often helped a struggling youth through college.

CHAPTER XLVI.

PHILANTHROPY.

GREAT GIVERS—GIRARD—PEABODY—OBERLIN—GEO. MULLER—MONTEFIORI—GIFTS TO SCHOOLS AND COLLEGES—EFFORTS FOR THE DEAF—THE BLIND, ETC.—A CENTURY OF BENEVOLENCE.

IT would not be possible in a work like this to even name the charitable institutions that within the last few years have been multiplied all over Christendom to mitigate and alleviate misfortune and suffering, nor to record the names of those who have glorified humanity by their deeds and beneficences. Deaf and Dumb and Blind Asylums; Hospitals for curable and incurable diseases; special Retreats for victims of cancer, spinal disease and other maladies; for the poor about to become mothers; for the aged; for orphans and other destitute children; in fact for every ill that flesh is heir to. Think of the homes for the friendless; for fallen women; for indigent old men, and women; houses of refuge for the night; for the unfortunate of all degrees,—indeed the Christian world is dotted all over with places of refuge to help the friendless and unfortunate; and the wealthy are more and more endowing them, so that it may truthfully be said that these friendly oases all over the desert of misfortune and need are everywhere inviting the wretched, where a century since very few if any of them were in existence. More charitable and benevolent and philanthropic institutions have been founded in the last hundred years than during the last eighteen centuries.

To the neglect of earlier times and to the ordinary almshouses of the last century have succeeded many special institutions for the care of different classes of unfortunates. Differentiation and intergradations have gone on continually until all classes of the degenerate and otherwise unfortunate are more and more classified and individualized and specialized means of cure and help are adapted to their conditions, with wiser care and deeper sympathy; so that it may be said that all classes of the poor and unfortunate are better cared for than ever before since time began. Never before was there so much effort in every direction to alleviate and ameliorate the condition of the poor and needy. In fact it may be said truthfully that the science of giving, systematic charity, is not more than a century old, though the instinct of benevolence has always prompted the generous to help the needy, ever since the oldest piece of literature extant was written, in which Job says: "When the ear heard me, then it blessed

me; it gave witness to me, because I delivered the poor that cried, and the fatherless, and him that had none to help him. The blessing of him that was ready to perish came upon me; and I caused the widow's heart to sing for joy. I was eyes to the blind, and feet was I to the lame. I was father to the poor; and the cause which I knew not I searched out."

Every possible alleviation of their sorrow is afforded to the needy. Little children who are sick have hospitals provided, where the tenderest care is lavished upon them. A separate home is maintained for children who are the victims of disease in spine or hip-joint. There are institutions in which medical advice is given gratuitously to the poor regarding the manifold ills to which they are heirs. Skilled nursing does much to promote the comfort and the recovery of the sick. "One association establishes lodging-houses, where the poor can live in comfort free from the allurements of vicious companionship. Another employs its resources in improving the condition of the poor by every device which Christian thoughtfulness suggests. Another watches over the destitute sick; and to the kindly words of its agents, adds an open-handed dispensation of comforts which are so needful in sickness, and yet so often unattainable. Indigent old men, indigent old women, decayed gentlewomen, enjoy the care of different societies. Philanthropists whose bounty was under guidance of orthodoxy, make provision for decayed old men and women "being Protestants." The blind and the deaf and dumb are received into homes where suitable occupations are found for them. Children, on whose youth there has fallen the calamity of loss of parents, are maintained and educated and equipped for the work of life. There are houses of refuge where homeless wanderers may turn aside to obtain shelter for the night. "The moral interests of the poor are cared for with an enlightened zeal which is beyond praise. Children who are without guardianship are snatched by merciful hands from the perils which surround them, and safely bestowed in institutions where they are taught simple industries and receive a wholesome education. Boys who love the sea are sent to training ships. For agricultural aspirants farm-schools are provided. Women who have fallen from virtue are sought out and gathered into institutions whose influences are directed toward their restoration. Criminals whose term of punishment has expired are taken charge of by a society, whose agents find for them honest employment and consequent deliverance from the

GEORGE W. CHILDS.

temptation to commit fresh offences. Self-denying persons, impressed by the enormous evils which our drinking usages produce, have banded themselves into societies, and strive with unwearied and heroic effort to lead drunkards back to sobriety. This disposition to raise the fallen, to befriend the friendless, is now one of the governing powers of the world. Every year its dominion widens, and even now a strong and growing public opinion is enlisted in its support."

The benefactions bestowed on institutions to benefit the world have been greater during this century than in any other—probably than in all others. Not counting the small gifts unrecorded, the amount bestowed on colleges, churches, charities, museums, art galleries, libraries, etc., in this country in 1894 was $19,967,116; in 1895, $28,943,549; in 1896, $33,670,129, and in 1897, $33,612,814. Of this magnificent total $20,233,378 has been contributed by men and $13,379,436 by women. The most munificent contributions for the year 1897 are as follows:

J. Pierpont Morgan, to charities, $1,000,000; Mrs. Leland Stanford, to Stanford University, $1,000,000; Winnifred Martin, churches, $1,000,000; John B. Deering, to charities, $2,000,000; Washington Corrington, to colleges, $1,000,000; George M. Pullman, for manual training school, $1,200,000; P. A. B. Widener, for art gallery, $1,000,000; Charles Contoit, to charities, $1,500,000; Henrietta R. F. Baker, to charities, $2,000,000.

The benefactions for education have been stupendous. Girard, Hopkins, Rockefeller, Cornell, Stanford, Schermerhorn, Sage, Havemeyer, the Vanderbilts, Vassar, Drexel, Pratt, Ames, and others may be named. During the first six months of 1899 ninety colleges, academies, and seminaries, and eight art institutes, received gifts aggregating $30,000,000, a larger amount than was ever contributed to similar purposes in double the period of time.

The pioneer in the century, in financial generosity, was Stephen Girard (1750-1831), who founded Girard Orphan College, Philadelphia, which was opened January 1, 1848. He left, at his death, $7,500,000, which now (1899) has grown to $27,000,000. During fifty years $11,350,000 has been expended to support and educate the 5,899 orphans who have been graduated.

During an epidemic of yellow fever and a reign of terror in Philadelphia, in 1793, he took personal charge of the hospital, attended to the sick himself, supplied money for the support of the poor, furnished burial for the dead and took permanently under his care 192 orphans. There has seldom been such an act of physical courage on the part of a layman, for Mr. Girard knew nothing whatever about medicine or nursing except what he had learned at sea, but his bravery and genius for organization brought the needed assistance and quieted the alarm of the people, which, however, was well justified, for one-tenth of the

entire population died from the epidemic.

Besides founding the college, Girard bequeathed money to several members of his family, his friends and dependants; to found a hospital; to aid an institution for the deaf and dumb, an orphan asylum, the public schools of Philadelphia and the grand lodge of Masons; to the city of Philadelphia for furnishing fuel to the poor, which must be bought annually in the summer and distributed in January; to the public schools of several places; to a society for the relief of the widows and children of shipmasters; for the erection of schoolhouses in different parts of Pennsylvania; to furnish food for the poor; to educate poor children in different places; to the captains and sailors of his vessels; to all his apprentices and servants, and to the city of New Orleans "to promote the health and prosperity of its inhabitants," and he gave annuities to the widows of several of his friends and the ship captains who had been in his employ.

SOCIAL SETTLEMENTS.—These movements in behalf of the poor are among the most useful of modern benevolences. The first settlement, "Toynbee Hall," London, was dedicated in 1885 in honor of Arnold Toynbee, a young Oxford tutor, whose labors made the experiment possible. The first in America was the College Settlement, Rivington Street, New York City. Hull House, Chicago, was founded the same year (1889). There are some thirteen in Chicago, and many others all over the English-speaking world. "The settlement is a great modern protest against the heresy that wealth makes character, that education can establish an aristocracy, that one can rise to a social pinnacle without obligation to those who have contributed to that rise, that men are by nature divided into classes by virtue of what they do and have rather than by what they are." It originates in a person or group of persons desiring for mutual benefit to share their lives and culture with their fellow men, taking up their residence somewhere—in the impulse to express this desire and making their home a social center for the community. There are no missionaries or charity workers among them. "They give their society, their personality and whatever of the good Samaritan spirit they possess personally; to that extent is their work religious. So a settlement is not a socialized mission at all, for it assails the social problem from quite a different point of view. A settlement in the distinctive sense of the term starts with the assumption that in any community there is always enough resident essential goodness, enough aspiration to save and uplift that community, if only it can be made self-conscious and given means to express itself." When, in 1860, the New York Children's Aid Society, the most extensive and important children's charity in the United States, took the position that a farmer's home, even the poorest, is better for a homeless child than any asylum or institution, the world soon perceived that a distinct advance had been made in thought and method

he old lines in the great prob-
f caring for a city's waifs; yet
's methods are as far in ad-
of the loose emigration plan
put in operation as that was
he asylum system. The most
natic appliances are now em-
d to rescue neglected children
degradation.

of the most useful of the
nities of the century is the
e, which receives little children
their hard-working mothers
mployed from home. They
e food and care.

other is the Fresh Air Retreat,
hich city children are sent for
eration.

n Frederic Oberlin (1740-1826),
mmortal pastor of Ban de la
e, was one of the most remark-
of the world's philanthropists.
gives most who gives himself."
lin gave himself to the most
omising of fields, and achieved
asting renown, with the fewest
east apparent advantages. In
ky territory of only 10,000 acres
Vosges mountains he labored
the age of twenty-seven to
y-six, nearly sixty years, and
s precept and example elevated
tire community from barbarism
vilization, in a way to render
ttle Lutheran parish an example
the world of what consecrated
tian effort can accomplish in
levation of mankind. He was
r, school-master, farmer, me-
c, physician, and the personal
and confidential friend of
soul in his little flock. He
the model Pastor, the Ideal
nthropist.

George Müller (1805-1898) was one of the great philanthropists of the century. He founded the Bristol Orphanage in 1835. For more than sixty years it reared and educated thousands of orphans, entirely by voluntary subscriptions. It had no endowment.

George W. Childs (1829-1894), the two Cherryble Brothers rolled into one, worked himself up from poverty until through the "Philadelphia Public Ledger" he amassed a fortune, and was so generous in his charities that he was called the "Santa Claus of the newspaper world."

Daniel Drew, Tufts, John R. Buchtel, Crerar, Angela J. Burdett-Coutts (1814), T. F. Buxton (1786-1845), Johns Hopkins (1795-1873), F. T. Hopper (1771-1852), Abbott Lawrence (1792-1855), Amos Lawrence (1786-1852), Lucretia Mott (1793-1880), Robert Owen (1771-1858), John Pounds (ragged schools) (1766-1839), Benjamin Rush (1745-1813), Arthur Tappan (1786-1865), Matthew Vassar (1792-1868), are among the distinguished givers of the century.

Most of the great colleges and libraries were founded before the present century. But the number has been immensely increased, and the strength and efficiency of the older ones multiplied. Among American colleges are Wesleyan, Middletown, Connecticut, 1830; Johns Hopkins, Baltimore, Maryland, 1876; Amherst, Amherst, Massachusetts, 1821; Williams, Williamstown, Massachusetts, 1793; University of Michigan, Ann Arbor,

1841; University of Virginia, Charlottesville, 1825; Cornell University, Ithaca, New York, 1868; Trinity, Hartford, Connecticut, 1823; Tufts, Somerville, Massachusetts; Buchtel, Akron, Ohio; Lombard, Galesburg, Illinois; University of California, Oakland, 1855; University of Chicago, Chicago, Ill., 1891; Vanderbilt, Nashville, Tennessee, 1875. Only a few of the multitudes of great givers can here be named.

John Lowell, Jr. (1799-1836), founder of the Lowell Institute, Boston, whose lectures began December 31, 1839; Andrew Carnegie (1835), founder of several free libraries, to the amount of more than $3,000,000; Thomas Holloway (1800-1883), the founder of the Holloway Sanatorium for the insane, near Windsor, England, costing $1,500,000, opened in 1885, and of Holloway college for women, in Surrey, England, costing $5,000,000; Charles Pratt (1830-1891), founder of Pratt Institute, Brooklyn, on which he bestowed $3,700,000; Sophia Smith (1796-1870), founder of Smith College, Massachusetts, for the higher education of women, $400,000, dedicated 1875; James Lick (1796-1876) giver of Lick Telescope, San Jose, California, and numerous charities amounting to $700,000; Leland Stanford (1824-1893) and wife, the founder of Leland Stanford, Jr., University, at Palo Alto, California, opened in October, 1891; Henry Shaw (1800-1889), donor of Shaw's Garden, St. Louis; James Smithson (1765-1829), founder of the Smithsonian Institution, Washington, District of Columbia; Enoch Pratt (1808), James Lenox (1800-1880), Walter L. Newberry (1804-1868), John Crerar (1889), John Jacob Astor (1763-1848), whose libraries are their enduring monuments; Anthony J. Drexel (1826-1893), Philip D. Armour, Asa Packer (1805-1879), Cornelius Vanderbilt (1794-1877), Maurice de Hirsch (1833-1896), who gave $15,000,000 yearly for five years before his death in charity; Isaac Rich (1801-1872), who endowed Boston University; William W. Corcoran (1798-1888); John D. Rockefeller is one of the greatest American givers (1839), except George Peabody. He has given $7,500,000 to Chicago University, incorporated in 1890, besides innumerable other generous sums; George Peabody (1795-1869) left $9,000,000 to the cause of education; S. G. Howe (1801-1876), Peter Cooper (1791-1883), Moses Montefiore (1784-1885), Sir Josiah Mason (1795-1881), Sir Titus Salt, founder of Saltaire; Ezra Cornell (1874), Catherine Lorillard Wolfe (1828-1887) gave millions in charity during her life, and at her death, etc.

These are but illustrious examples of thousands of those whose benefactions have blest the world. Their mere names—the Abou Ben Adhems of the century—would fill a volume. In the roster of fame their names "lead all the rest."

The wonderful advance made during the century in the treatment of deaf mutes is another of the century's triumphs. They are no longer deliberately drowned, as in ancient Rome, nor exposed to die, as under the laws of Lycurgus, but

ADMIRAL GEORGE DEWEY.

"The hero of Manila illustrates the noblest qualities that distinguish American manhood."

s being realized that they are e to learn, be or do anything and rything the hearing can, if they given precisely the same advan- es and opportunities. It has been ved by experience that if the ntion of the deaf child be directed the mouth with persistency, and be talked to just the same by ry one who is with it, that it will rn the speech and language ough the eye which the hearing ld learns through the ear. They taught to talk in the schools for deaf in Germany, Italy, Holland, itzerland, France, England, and erica, and the prophecy has been rally fulfilled in thousands of es, "The tongue of the dumb ll sing." (See "Medicine.")

ardiner G. Hubbard (1822-1897), 860, found his daughter, Mabel, sequently the wife of Professor l, inventor of the telephone, f, as the result of sickness. He nded the first school in this coun- for teaching the deaf. He main- ed this school for some years at his own expense, and appreciating the great importance of the work, urged the subject upon the atten- tion of the public and the state, and measures were adopted which re- sulted in the establishment of the Clarke School, at Northampton, Massachusetts. He early became interested in the Bell telephone, and in 1878 retired from practice of the law to devote himself to its interest. He was the controlling spirit in its financial affairs during the next five years.

The teaching of deaf mutes by the "visible speech method" has been revolutionized, and the condition of that unfortunate class wonderfully improved. It was discovered by Alexander M. Bell, in 1866. In all civilized countries institutions are devoted to their instruction.

The blind were first able to read by raised letters, but since 1825 the invention of Braille is used, a system of raised dots and points. A Bible for the blind was first published in Glasgow, in 1848.

CHAPTER XLVII.

NEW SECTS.

NEW RELIGIOUS MOVEMENTS AND DENOMINATIONS DURING THE CENTURY—HICKSITE QUAKERS—UNITARIANS—REFORMED EPISCOPALIANS—UNIVERSALISTS—MILLERTES—OLD CATHOLICS—BRAHMA-SOMAJ—POSITIVISTS.

AMONG the factors that have contributed to the evolution and progress of the world during the century are the new religious sects that have emphasized certain phases of religious thought, and that have appeared during the Nineteenth Century, each can no doubt be credited with contributing something to the progress of the world.

Southcottians.—The followers of Joanna Southcott (1750-1814), whose circumstances were so poor that she had to become a domestic servant. She had strong religious feelings, and, till about the age of forty, was a member of the Methodist body. In 1792 she professed to receive revelations, which she published in 1801-3. These were partly in prose, but chiefly in doggerel. From that time to her death the number of believers in her pretensions largely increased. These were by no means confined to the uneducated classes, and they made such provision for her as enabled her to live in considerable style. In return for their offerings her followers received seals —papers which purported to number them with the mystical "hundred and forty-four thousand" of the Apocalypse (vii:4). In 1813 Joanna announced that she was about to be come a mother, that the child would be miraculously conceived, and would be the Shiloh (Gen. xlix:10) in whom the millennium was to be established. On her tombstone, in Marylebone churchyard, is an inscription foretelling her reappearance. Shortly before her death, the Rev. J. T. Foley, rector of Old Swinford, on her behalf announced to her followers that she had received a heavenly command that they were not to assemble for worship till after the birth of Shiloh, but to attend Protestant churches. In 1825 Charles William Twort (whose followers were called Turnerites) arose about the same time. The last leader of the Southcottians was John Wroe, of Bowling, near Bradford. He claimed prophetic gifts, and taught that the second advent was at hand. His adherents, who are called Christian Israelites, are much stronger in Australia (where Wroe died in 1863) than elsewhere.

Christians, usually known as Christians, began to exist as an organized sect about 1800, in North Carolina, Kentucky, and Vermont. They are evangelical in their general doctrines, but have no creed but the

Bible, and no head but Christ. They were divided into north and south wings during the civil war.

Universalism is the doctrine that all souls will finally become holy and happy. The belief is very ancient, and it may be found in the works of Origen and his followers, Gregory of Nyssa, Chrysostom, etc., Clement of Alexandria, from the first to the fifteenth century. It began in modern times as a distinct movement, under John Murray (1741-1815) in 1770, and was organized in 1803, in Winchester, New Hampshire, as a church, with the following profession of faith: Article I.—We believe that the Holy Scriptures of the Old and New Testaments contain a revelation of the character of God and of the duty, interest and final destination of mankind. Article II.—We believe that there is one God, whose nature is Love, revealed in one Lord, Jesus Christ, by one Holy Spirit of Grace, who will finally restore the whole family of mankind to holiness and happiness. Article III.—We believe that holiness and true happiness are inseparably connected, and that believers ought to be careful to maintain order and practice good works; for these things are good and profitable unto men.

Disciples of Christ.—The name assumed by a religious sect, otherwise known as Campbellites, Reformers, or Reformed Baptists. It took its rise from the zealous efforts of Rev. Alexander Campbell (1780-1866), an Irish Presbyterian minister, to bring about a union of all Christians in one fold, the fundamental point being that the Bible alone should be taken as the authorized bond of union and the infallible rule of faith and practice. His first congregation was organized in Pennsylvania, in September, 1810. The Disciples of Christ hold the doctrine of adult baptism, but in many points differ from the Baptists.

Primitive Methodists, nicknamed "Ranters."—A section of the Wesleyan community which arose in Staffordshire, England, under leadership of Mr. Hugh Bourne (1792-1852). Having held camp-meetings like those of America, he was censured for it by the English Wesleyan Conference in 1807 and, seceding, formed a new connection, the first class-meeting of which was held at Standley, in Staffordshire, in 1810. In doctrine the Primitive Methodists agree with the Wesleyans.

Bible Christian Methodists in 1852 had 403 chapels, 113 itinerant ministers, 1,059 local preachers, and 13,682 communicants. They are sometimes known as Bryanites.

Bryanites.—Founded by Mr. William O. Bryan, a Wesleyan local preacher in Cornwall, England, who, separating in 1815 from the main body of the Wesleyans, began to form separate societies. In 1829 he left the body he had formed.

The Wesleyan Reformers, New Connection, and other subdivisions of this body, have appeared from time to time, with slight differences from the parent body.

Unitarianism began as a distinct church in this country in 1815, when William Ellery Channing (1780-1842) came out as Unitarian. His Balti-

more sermon (1819) marks the cleavage between the Unitarian and Orthodox sections of the Congregational body. In 1825 the British and Foreign Unitarian Association was organized. Unitarians have no formal test of membership, and have always shown great varieties of opinion. Priestley's Unitarianism includes a determinist philosophy and a strong element of supernaturalism. The return to a spiritual philosophy was initiated by Channing. Many of his followers, influenced by Emerson and Parker, have done their best to relieve Christianity of its supernatural ingredients. All own a spiritual allegiance to Christ, though varying as to the nature and extent of his authority. Appealing to Scripture as a witness for their views, Unitarians have generally limited revelation to the communication of spiritual data. They reject a substitutionary atonement, and are usually advocates of a universal restoration.

The Church of the New Jerusalem was formally organized this century, in 1810. In April, 1745, being in an inn in London, Emanuel Swedenborg (1688-1772) considered that he had a vision of the Lord, who called him to a holy office, opened his sight to the spiritual world, and endowed him with the gift of conversing with spirits and angels. In August he returned to Stockholm, commenced the study of the Hebrew scriptures, resigned his assessorship in 1747, and spent the remainder of his life in forming and propagating his theological views. His system is pre- [illegible] at length in his various works, especially his "Arcana Caelestia" (eight Vols., London 1749-1756). He believed that he was several times allowed to enter heaven, "Which was arranged in streets and squares like earthly cities, but with fields and gardens interspersed." There was a magnificent palace, with a temple in the midst, with a table in it, and on the table the Word of God, with two angels by its side. The form of angels was altogether like that of men. Matter and spirit are connected by an eternal law. He accepted only twenty-nine of the Old Testament books, and of the New Testament he accepted only the Gospels and the Apocalypse. He held that there is a double sense in scripture, the most important being the spiritual. He believed in one God; and that the Lord and Saviour Jesus Christ was that God; that Jehovah Himself became incarnate as the Word. Heaven and hell are not places, but states, and the devil is not a person, but a name of hell. The judgment on the first Christian church took effect in 1757, and was seen by Swedenborg, in the spiritual world, after which, and in lieu of it, the New Church, called in Revelation (xxi., 22.) New Jerusalem, descended from heaven. Swedenborg himself founded no churches.

Hermesianism.—The method of religious inquiry taught by George Hermes, born near Munster, April 22, 1775. In 1819 he became professor of theology at Rome, where he died May 26, 1831. Hermes combined with Roman Catholicism, to which he was sincerely attached, a strong tendency toward philoso-

He published his views, in in an introduction to Chris- Catholic theology. His old ents and other admirers, who numerous, adopted his method, the result that they tended to e, not toward, but away from hurch, in consequence of which Pope, on September 26, 1835, d a brief against Hermes' work, h was held to be of infidel ten- y.

iritualism.—A system of pro- d communication with the un- world, chiefly through persons d mediums. It is asserted that ts manifest their presence by by unfastening knots, by trans- ition of furniture and human gs through the air, by the turn- nd tilting of tables, by writing ates, playing on musical instru- ts, imparting phosphorescence ertain objects, and, in some , by becoming partly or entirely rialized in human form. The phenomena were in 1844, in lia, New York. The "Spiritual azine" says: "Spiritualism is d on the cardinal fact of spiritual nunion and influx. . . . It is olic and progressive, leading to religion as at one with the est philosophy."

angelical Association. — The ights, or German Methodists, substantially at one with other odists. The membership is t 100,000.

e African Methodist Episcopal ch was organized on account of olor prejudice of other Metho- . They have made such pro- that in 1890 there were forty-four conferences, 2,481 organizations, 4,124 church edifices, 452,725 members, and $6,468,280 church property.

The Zion African Methodist Episcopal Church was organized in 1879. They elect their bishops annually. In 1890 there were 1,704 organizations, 1,611 places of worship, and 349,788 members.

Wilburites.—A section of American Quakers, named from their leader, John Wilbur (1774-1846), who separated from the main body in the first half of the Nineteenth Century, on the ground that the Quakers were abandoning their original principles.

The Hicksite Quakers. — The Hicksite secession took place in 1827. Elias Hicks (1748-1830) and his followers objected to the view of Christ's divinity and atonement held by the main body. In 1890 the Hicksites numbered seven yearly meetings, 2001 congregations, 217 meeting houses, and 21,992 members.

Adventists believe in the immediate coming of Christ. They generally hold to conditional immortality, that the faithful at our Lord's coming will inhabit the re-habilitated earth, in a condition of immortal blessedness, and that the wicked will not be raised. They are sometimes nicknamed "Soul Sleepers." The founder of the sect was William Miller, who began to preach the immediate end of the world in 1833. Different dates have from time to time been assigned as the time of the catastrophe. There is a branch that repudiates the doctrine of the

destruction of the wicked, and another that observes the seventh day as Sunday. The majority of Adventists do not fix the date of the second coming. There are some 1,800 organizations, of all divisions, with 60,000 members.

Millerites.—Followers of William Miller (1781-1849), an American premillennialist, or Second Adventist, who expected the immediate return of Jesus to reign upon the earth. Believing in the literal fulfillment of the prophecies, the Millerites asserted that the first judgment would take place in 1843. Subsequently other periods were named; and so firm was the faith of many that they disposed of all their worldly goods, provided themselves with ascension robes, and waiting with anxiety for the sounding of the last trumpet—the signal for their elevation.

Ebelians.—A revivalist sect of German mystics, which arose in Königsberg, Prussia, about A. D. 1830, J. W. Ebel (1784-1861) and Doctor Dieste being its leaders. They believed in spiritual marriages, and professed great purity of life. In 1839 sentence was passed against their leaders, who were charged with unsound doctrine and impure lives, but it was removed in 1842. Their enemies called the sect Muckers, i. e., in German, Hypocrites.

Evangelical Alliance.— An alliance first suggested at a conference held in Liverpool, England, in October, 1845, and inaugurated at a series of meetings in London, between August 17 and September 2, 1846. The following nine tenets were adopted as the basis of union: 1. The divine inspiration, authority, and sufficiency of the Holy Scriptures. 2. The right and duty of private judgment in the interpretation of the Holy Scriptures. 3. The unity of the Godhead, and the trinity of persons therein. 4. The utter depravity of human nature in consequence of the fall. 5. The incarnation of the Son of God, His work of atonement for sinners of mankind, and His mediatorial intercession and reign. 6. The justification of the sinner by faith alone. 7. The work of the Holy Spirit in the conversion and sanctification of the sinner. 8. The immortality of the soul, the resurrection of the body, the judgment of the world by our Lord Jesus Christ, with the eternal blessedness of the righteous and the eternal punishment of the wicked. 9. The divine institution of the Christian ministry, and the obligation and perpetuity of the ordinances of baptism and the Lord's Supper.

The Evangelical Alliance is not a federation of various churches; it is composed of individual Christians connected with different denominations.

Free Church of England.—A result of the Tractarian Movement of 1832 in England, founded on the basis of recognizing only two orders, the first being presbyters, and the second deacons. The governing body is the Convocation, consisting of all the church and all the laity.

Old Catholics.—The name assumed by a body of German priests and laymen who refused to accept the dogma of Papal Infallibility, and, in consequence of its definition.

formed themselves into a separate body. It was essentially a university movement, of the German bishops who had left Rome to avoid voting—Hefele among the number—afterward submitted. Van Schulte, a professor of Prague, published a formal protest; then came the Nuremberg protest of "Catholic Professors" (August, 1870). Father C. L. Hyacinthe's (1828) "Appel aux Evêques" followed in La Liberta early in 1871, and (March 28) Doctor J. J. I. Dollinger (1799-1890) set forth his reasons for withholding his assent "as a Christian, a theologian, an historical student, and a citizen." Dollinger and Friedrich were immediately ex-communicated. The first synod (1874) made confession and fastings voluntary; the second (1875) reduced the number of feasts, and admitted only such impediments to marriage as were recognized by the state; the third (1876) permitted priests to marry, but forbade them to officiate after marriage. This prohibition was annulled by the fifth synod (1878), and, in consequence, Friedrich, Reusch, and some others withdrew. Congregations of Old Catholics exist in Austria, Italy, Spain, Switzerland, France and Mexico, but their numbers are small. In Germany they seem to be dwindling away, but the protest of Döllinger and his fellows will remain an important landmark in religious history.

Peculiar People.—A Protestant sect of recent origin, found mostly in Kent, England, and to a less degree in other counties round London. They recognize no sacraments or creeds, and claim to be the real exemplars of true and undefiled religion. They accept the exhortation of Saint James (v., 14, 15) in a strictly literal sense, and this has more than once led to a verdict of manslaughter being returned against some of their members by a coroner's jury. (McClintock and Strong.) The analogue of this sect in this country is to be found in the Faithcurists. The name apparently has reference to I Pet. ii., 9.

Plymouth Brethren.—A body which arose almost simultaneously in Dublin and Plymouth, about 1830, and, as they called themselves "The Brethren," outsiders came to know them as "Plymouth Brethren," from the town where they had fixed their headquarters. Their chief founder was a lawyer, named Darby, who had taken orders. Their communities are of what is known as the Evangelical Calvinistic type, and many of them maintain that only among themselves is true Christianity to be found. They have no regular ministry, every brother being at liberty to prophesy or preach whenever moved to do so. They baptize all adults, whether previously baptized or not, and observe the sacrament of the Lord's Supper weekly. They are rigid Predestinarians, and expect the Millennium.

Restitutionists.—A religious sect, which has recently sprung up in New England. They believe that what man lost in the fall is now beginning to be restored, and that everything is to come back to its original form and purity. Their Sabbath occurs on Saturday.

Thomasites or Christadelphians.—(From John Thomas, M. D., 1805-1871.) A controversial name sometimes given to the Christadelphians, from the fact that Dr. John Thomas organized them into a separate religious body. They believe that immortality is the reward of the righteous, i. e., of those who receive the truth and are baptized, and that others will perish after punishment proportioned to their misdeeds or want of faith. They do not believe in the trinity or in a personal devil.

Wakemanites.—A small party of fanatics existing at New Haven, Connecticut, in 1855, who regarded an old and apparently insane woman, named Rhoda Wakeman, as a divinely-commissioned prophetess, who had been raised from the dead. At her bidding, some of her followers murdered a small farmer, Justus Matthews, who, she said, was possessed of an evil spirit. The unfortunate man willingly submitted to the sentence pronounced by the pseudo-prophetess, but the extinction of the sect followed as a matter of course.

United Brethren.—Dayton, Ohio, is the headquarters of the sect, which was founded by Philip William Otterbein (1732-1813), at Baltimore, in 1800. Otterbein was a member of the Dutch Reformed Church, but the United Brethren claim that their creed is independent in all its principles. The sect has branches throughout the United States and many missions in China, Japan and Africa. The financial strength of the United Brethren is said to be great and fast increasing.

The Brahma-Somaj is a Hindu theistic sect, existing chiefly in Bengal. It was founded by Rammohun Roy (1772-1833). At the age of sixteen he began to attack the idolatry of modern Hinduism, and continued to do so throughout his life, on the ground that it was not countenanced by the Vedas. He opposed the burning of the widows. In 1820 he sent forth in English, Sanskrit, and Bengalee, a series of extracts from the New Testament, entitled: "The precepts of Jesus, the Guide to Peace and Happiness." He believed in the divine mission of Christ, but held at the same time the Vedas to be a revelation of God. One great step of progress was taken in India in 1829, when Suttee, or widow-sacrifice, was abolished. In Calcutta between 1813 and 1828 between 390 and 600 widows were annually burnt. The practice was formerly common in India. The widow was burned with her dead husband on the funeral pyre. Many went willingly and gayly to their doom, but others were driven by fear of disgrace, by family influence, by priestly threats, and, in not a few cases, by sheer violence.

Agnostics.—Those who believe that nothing can be known beyond what man can learn through his senses or his affections. Positivists and Secularists are of similar opinion.

Brotherhood of the New Life, established in the latter half of this century, in Brocton, New York, but later in Sonoma County, California. Its founder was Thomas Lake Harris (1823), a follower of Andrew Jackson Davis (1826). Common repute

es the "Brotherhood" a nest of uity.

erfectionists, Bible Communists, 'ree Lovers.—Under the leader- of John H. Noyes (1811-1886), began to be about 1854, and ned to be free from the prin- es of morality and to be governed religious considerations only. es had been an Independent min- at Yale College, New Haven, necticut. He professed to have overed from the writings of St. l that all Christian sects were in itual darkness, and determined establish a church of his own. founded a community at Oneida, York, and others subsequently Vallingford, New Haven, and York, in order to carry out t he asserted to be a divinely re- ed system of society, based on following principles: (1) recon- tion with God; (2) salvation from (3) brotherhood of man and nan; and (4) community of labor, of its fruits. They are called "Bible Communists and Free ers."

ositivism.—Founded by Auguste ite (1798-1857). The religion of anity, developed from the pos- philosophy, and claiming to be nthesis of all human conceptions ie external order of the universe. rofessed aim, both in public and ate life, is to secure the victory ocial feeling over self-love, of ism over egoism. According *Encyclopedia Britannica* ed. 9th, 237, it is really "utilitarianism, rned by a fantastic decoration," the "worship and system of olicism are transferred to a system in which the conception of God is superseded by the abstract idea of humanity, conceived as a kind of personality."

Secularism.—The name given, about 1846, by Mr. George Jacob Holyoake, to an ethical system founded on natural morality. "Secularism is that which seeks the development of the physical, moral and intellectual nature of man to the highest possible point, as the immediate duty of life—which inculcates the practical sufficiency of natural morality apart from Atheism, Theism, or the Bible—which selects as its method of procedure the promotion of human improvement by material means, and proposes these positive agreements as the common bond of union, to all who would regulate life by reason and ennoble it by service."—G. J. Holyoake (1817), Principles of Secularism (ed. 1859), p. 17.

The Mormons.—The popular name for the members of a religious body calling themselves "The Church of Jesus Christ, of Latter-Day Saints," or more briefly, the Latter-Day Saints. Their founder was Joseph Smith (1805-1844), a farmer's son, born in Sharon, Windsor County, Vermont, December 25, 1805. He asserted that on September 21, 1823, as he was praying, a supernatural light shone in his room, and an angel appearing made revelations to him, and next day gave him certain engraved plates, with an instrument called the Urim and Thummim (cf. Exod., xxviii, 30; Lev., viii, 8), by the aid of which he translated them, publishing the result in 1830 as the

Book of Mormon. They believe in the Bible and the Book of Mormon. They hold the doctrine of the trinity, the atonement, baptism by immersion, the second advent, and the restoration of Israel; they deny original sin. They recognize Joseph Smith and his successors as prophets and revelators; they claim for some of their number miraculous gifts, and considered polygamy lawful prior to an edict from the head of the church against it. The anti-polygamous Mormons, organized before polygamy was abandoned, as their name implies, repudiate polygamy.

Owenites.—A name sometimes applied to the followers of Robert Owen (1771-1858), a noted socialist and philanthropist, whose industrial community at New Lanark, on the Clyde, excited great attention in the early part of this century. Meeting with opposition from the clergy, he came to this country, and in 1824 founded a similar colony in Indiana, where the co-operative system was introduced, and a modified communism adopted. The colony existed for about three years, but was abandoned about 1827.

Salvation Army and Volunteers.—An organization, practically a Christian sect, founded by William Booth, born in England in 1829. The first appearance of the title Salvation Army in the Registrar-General's returns was in 1880. With the name army came military phraseology. Prayer became knee-drill, the leader became a general, one of his sons chief of the staff, evangelists took the name of officers, candidates were cadets; and not merely converts were sought, but recruits. A semi-military attire was assumed, barracks built instead of separate residences, and when the army marched forth to take some place by storm, it was with banners displayed and bands of music leading the march. Its possession of the streets was not undisputed, especially in the earlier part of its career. Religious soldier-life was open to women, and many female officers conducted evangelistic operations. The progress of the army was very rapid. The amount of property owned by this organization now exceeds $4,000,000, and the annual income is over $3,600,000. The Division of the army in this country in 1893 had 1,695 officers, 556 corps, eleven slum posts, five rescue homes, and three food and shelter depots. The platform of belief on which the Salvation Army wages its warfare with sin declares that the Scriptures of the Old and New Testaments were given by inspiration of God, and that they only constitute the Divine rule of Christian faith and practice; that there is only one God, who is infinitely perfect, the Creator, Preserver and Governor of all things; that there are three persons in the Godhead—the Father, the Son, and the Holy Ghost, undivided in essence, co-equal in power and glory, and the only proper object of religious worship; that in the person of Jesus Christ the divine and human natures are united, so that He is truly and properly God, and truly and properly man; that our first parents were created in a state of innocence, but by their dis-

ce they lost their purity and ss, and that in consequence fall, all men have become totally depraved, and as justly exposed to the wrath that the Lord Jesus Christ His suffering and death made ement for the whole world, whosoever will may be saved; entance toward God, faith in d Jesus Christ, and regener- the Holy Spirit, are neces- salvation; that we are justi- grace through faith in our sus Christ, and that he that h hath the witness in him- at the Scriptures teach, that y does continuance in the God depend upon continued , and obedience to Christ, t it is possible for those ve been truly converted to y and be eternally lost; that e privilege of all believers to olly sanctified," that "their pirit and soul and body" may eserved blameless unto the of our Lord Jesus Christ." to say, that after conversion emains in the heart of the inclination to evil, or roots rness, which, unless over- l by Divine grace, produce in; but that these evil ten- can be entirely taken away Spirit of God, and the whole us cleansed from everything to the will of God, or en- anctified, will then produce its of the Spirit only, and rsons thus entirely sanctified the power of God, be kept able and unreprovable before They believe in the immortality of the soul; in the resurrection of the body; in the general judgment at the end of the world; in the eternal happiness of the righteous; and in the everlasting punishment of the wicked. In 1896 a schism occurred between the British and the American Salvationists, the latter forming an independent body called the Volunteers. The Episcopal church has organized a complement to the Salvation Army, the Brotherhood of St. Andrew, which labors among the poor. It was organized in 1882. It sustains labor, homes, furnishes meals to the needy, and proclaims the Gospel to the multitude.

Reformed Episcopal.—The Reformed Episcopal Church holds "the faith once delivered unto the saints," and its belief in the Holy Scriptures of the Old and New Testaments as the Word of God, and the sole rule of faith and practice; in the creed "commonly called the Apostles' Creed"; in the divine institution of the sacraments of baptism and the Lord's supper, and in the doctrines of grace substantially as they are set forth in the Thirty-nine Articles of Religion. I. This church recognizes and adheres to episcopacy, not as of divine right, but as a very ancient and desirable form of church polity. II. This church, retaining a liturgy which shall not be imperative or repressive of freedom in prayer, accepts the book of common prayer, as it was revised, proposed and recommended for use by the general convention of the Protestant Episcopal church, A. D. 1875, reserving full liberty to alter, abridge,

enlarge and amend the same, as may seem most conducive to the edification of the people, "provided that the substance of the faith be kept entire." III. This church condemns and rejects the following erroneous and strange doctrines as contrary to God's Word; First. That the church of Christ exists only in one order or form of ecclesiastical polity. Second. That Christian ministers are "priests" in another sense than that in which all believers are "a royal priesthood." Third. That the Lord's table is an altar on which the oblation of the body and blood of Christ is offered anew to the Father. Fourth. That the presence of Christ in the Lord's supper is a presence in the elements of bread and wine. Fifth. That regeneration is inseparably connected with baptism.

Jerkers, Barkers, are of no particular theology, but manifest an ignorant fanaticism at camp meetings, jumping, shouting, dancing, barking, etc.

Theistic Church. — A church founded in London in 1871, for the purpose of promulgating the theistic views of the Rev. C. Voysey (1828), "which the decision of the privy council (1870) has debarred him from preaching as vicar of Healaugh." Their leading principles are: (1) That it is the right and duty of every man to think for himself in matters of religion. (2) That there is no finality in religious beliefs; that higher views of God are always possible. (3) That it is our duty to obtain the highest truth, and to proclaim it and to detect and controvert errors. (4) That religion is based on morality. (5) That Theism is not aggressive against persons, only against erroneous opinions. Their belief may be summarized thus: (1) That there is one living and true God, and there is no other God beside Him. (2) That He is perfect in power, wisdom, and goodness, and therefore every one is safe in His everlasting care. (3) Therefore that none can ever perish or remain eternally in suffering or in sin, but all shall reach at last a home of goodness and blessedness in Him.

Christian Science.—A religious and theosophical system, propounded about 1866, in Boston, by Mary B. G. Eddy, and since that time adopted by a number of associations throughout this country and in England. The extract below, from the pen of one of its adherents, will give the best idea of its claims and tenets: "Christian Science is the explication of truth, reducing to human apprehension and demonstration the infinite principle, divine Love, God—manifested in the annihilation of sin, sickness and death. Christian Science is Christ-science or Emanuel knowledge, and involves the ultimate of all reason, revelation and inspiration. This church is built on the spiritual interpretation of the Scriptures. In Christian Science, God is demonstrated as infinite Love, omnipotent, omniscient, and omnipresent Spirt; the only Life, Substance, and Intelligence, and man as His idea or reflection. This at-one-ment with God, Jesus demonstrated. Christian Science unites science and Christianity, basing its God as eternal Love, the universal

Father and Mother, thereby establishing the brotherhood of man. The scientific creation is the infinite expression of infinite love, entirely spiritual. Its medicine is the Divine Mind. The ultimate of Christian Science is the establishment and recognition of spiritual harmony—to this end it heals the sick and sinful as Jesus did. In logic, Christian Science is indisputable. In demonstration of the power of mind over matter, it is mathematical, irrefutable and biblical. The foundation truths of Christian Science are—the reality and allness of God, the unreality and nothingness of matter, the spirituality of man and the universe, the omnipotence of good, the impotence of evil. The demonstrative actuality of Christian Science essentially distinguishes it from all other religions of the age."

The differentiation of Christianity into sects has wonderfully contributed to the growth of the Christian religion. There were in all the world in 1800 less than 200,000,000 Christians, out of an entire population of 1,000,000,000; in 1900 there are nearly 500,000,000, out of a population of 1,400,000,000. In other words, Christians have increased from one-fifth to about one-third.

CHAPTER XLVIII.

THE BIBLE.

BIBLE SOCIETIES—THE REVISION—HISTORY OF BIBLE CIRCULATION, ETC.

NEVER before was the word of God so distributed among people of all languages as now. In fact its general and systematic circulation was not begun until the "Century of Centuries" was born.

The first movement was organized in London. On Dec. 7, 1802, Mr. Joseph Tarn introduced the subject of the scarcity of Bibles in Wales, at a small gathering of Christian people in London. On this the Rev. Mr. Charles, who was present, and had been impressed by hearing, shortly before, from a Welsh girl that she was in the habit of journeying over the hills seven miles every week to obtain a sight of the sacred volume, proposed that a subscription should be set on foot for printing the Bible for circulation in Wales. The Rev. Jos. Hughes, a Baptist minister, suggested as an amendment that the intended effort should not be for Wales simply, but for all the world. From this small germ the great Bible Society sprang. It came into existence in 1803, under the name of "The Society for Promoting a more extensive Circulation of the Scriptures both at Home and Abroad." Next year, on March 7, 1804, it was more formally constituted at a meeting held in the London Tavern, Bishopsgate, its too lengthened designation being changed for the briefer and more telling one which it still retains, "The British and Foreign Bible Society." Its rise to power was rapid. On March 28, 1809, an auxiliary Bible Society was established at Reading, and many similar auxiliaries or branches soon followed in other places.

Up to March 31, 1880, it had taken a more or less direct share in the translation, printing, or distribution of the Scriptures in 233 languages or dialects, the number of the versions being 282; and had put into circulation more than 88,000,000 Bibles, Testaments, or Scripture portions, at an expense of above $40,000,000. During the year ending March 31, 1880, there were issued from its depots at home or abroad 2,780,362 copies of the Bible in whole or in part. The net income for the year was $350,000 7s., 9d., making, with contributions for special objects and the proceeds arising from the sale of Scriptures, a total of $1,000,000.

The German Bible Society was formed at Nuremberg in 1804, and afterward transferred to Basle.

The Prussian Bible Society, so named in 1814, developed out of the Berlin Society, was formed in 1804 or 1805.

The Hibernian Bible Society was formed in 1806.

The Philadelphia Bible Society, the first in the United States, was founded in 1808.

The City of London Bible Society was founded in 1812.

The Russian Bible Society was established under the auspices of the Emperor Alexander in 1813, but was suppressed in 1826 by his successor, Nicholas, 1831.

The National Bible Society of Scotland was founded in 1860, with which the Edinburgh Bible Society (1809) and the Glasgow organization (1812) are now incorporated.

Bible societies, though wide in their constitution, are practically Protestant institutions; and on June 29, 1816, a bull denouncing them was launched by Pope Pius VII.

The American Bible Society was established in 1818. Sixty delegates from twelve states of the Union, met in New York City and organized the Society. Its purpose was to supply America with the Word of God, and then to spread the light of the knowledge of the glory of God through the heathen world. During the seventy-five years of its history it has received into its exchequer for these laudable purposes the magnificent sum of $20,864,962.15. Four times during its history—in 1829, 1856, 1866 and 1882— a general supply of Bibles was issued, with a view of placing the Bible in every home in America. In the first twenty-five years of its history, 2,798,366; second twenty-five years, 18,987,210; third twenty-five years, 32,448,136; total, 54,233,712 were distributed. In addition to this, millions of Bibles have been issued to distant lands. The headquarters of the society are in New York City.

The Revised Version was one of the most important works of the century in reference to the study and understanding of the Bible. The resolution to undertake it was originated by the Convocation of Canterbury England, in February and May, 1870, and various members were nominated to carry out this work. Co-operation was sought from scholars in other churches and from an American committee. A better text was constructed, manuscripts being used which had been discovered since the Authorized Version had been made. Revision, not translation, was aimed at, as few alterations as possible being introduced, and these only if adopted by the votes of two-thirds of the translators. It follows that a new rendering might commend itself to the majority of them, and yet be relegated to the margin, while that which had only a minority of votes was left in the text. The headings of chapters and pages, paragraphs, italics, and punctuation were to be revised, and finally the headings were omitted. Poetry was printed in lines, showing the rhythm. The New Testament was published in May, 1881, the Old, in May, 1885.

In 1838 the Bible had been translated into 136 languages. It is now read in 350.

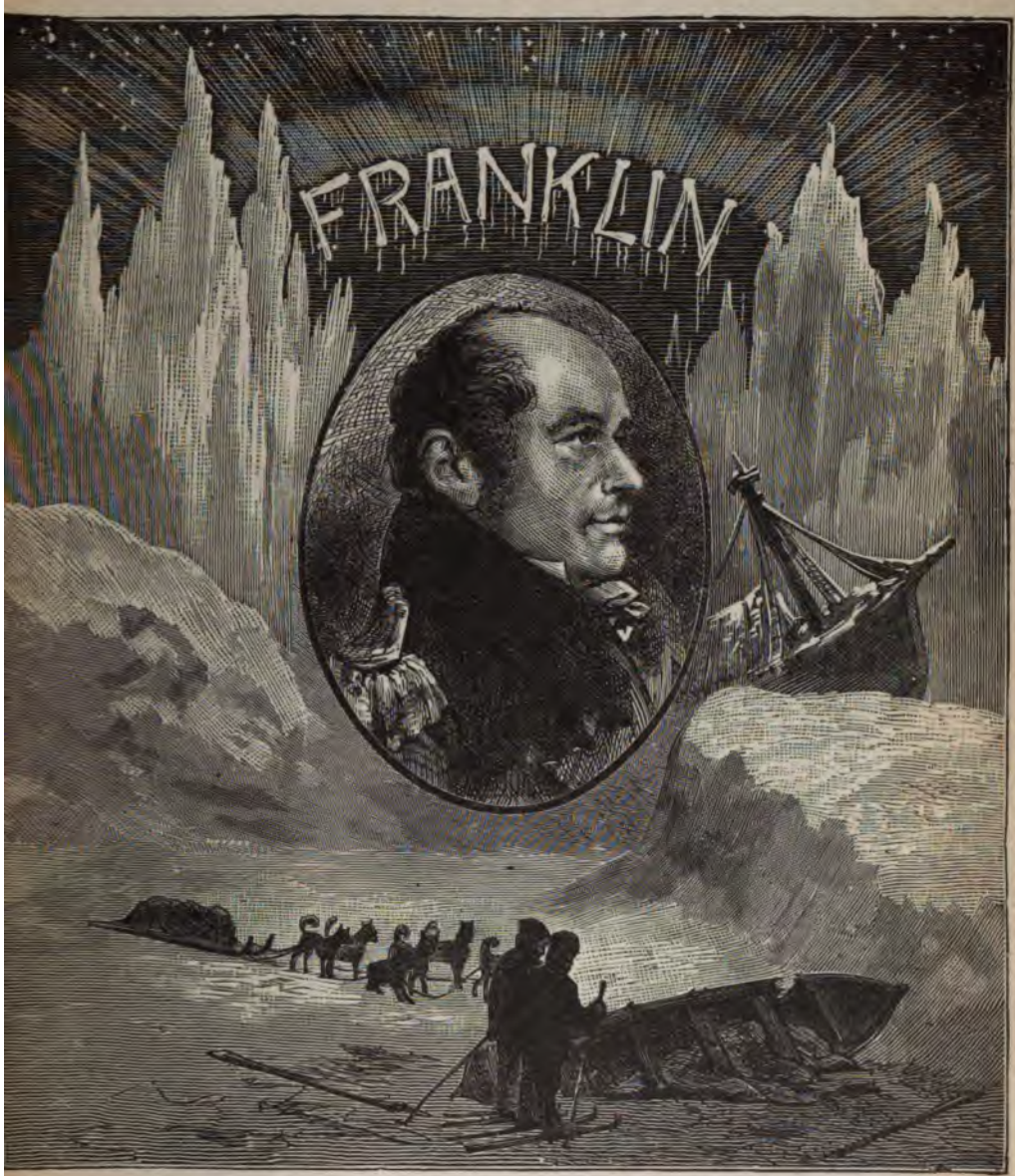
From the time when Layard brought back his treasures from Babylon and Nineveh, the books of Moses have received a new and

increasing corroboration. Mariette, Brugsch Bey, and other careful explorers into the sands and tombs of Egypt, have brought to the surface a vast amount of monumental records, which confirm in a new and startling way the whole history of that period. The buried cities, such as Pithom, Bubastis, and others, are made to tell anew the great tragedy of the downfall of the Pharaohs and the escape of the posterity of Jacob. Over forty years ago Tischendorf discovered on Mount Sinai the loose parchment sheets of large portions of an unknown codex of the gospels. Instead of the Codex Sinaiticus disturbing the received text, it has only strengthened its hold upon the faith and reverence of the biblical critics. The still later discovery of other scriptural records in the same place, the Convent of Saint Catherine, on Mount Sinai, by two English ladies, Miss Gibson and Mrs. Lewis, only confirms the triumph of Tischendorf. Modern researches have strengthened the hold of the Book of Books on the mind and in the affections of mankind.

Not only has Christianity had a most extraordinary numerical growth, but it has expanded and broadened in its spirit. Sects that were in conflict now live peacefully together, and the character of God and man is represented in altogether a brighter light than ever before, since the early promulgation of Christianity by its author and his immediate followers. The Christian world is broader and kinder in spirit than it was a hundred years ago. The spirit of Christ is far better illustrated by the great mass of Christians than then. The universal Fatherhood of God, and the universal Brotherhood of Man—terms almost obsolete a century ago—are now the staple of most pulpits, and the theme of most Christians, and not only are these divine affirmations uttered in all pulpits, but they are more nearly illustrated in institutions and in man's dealing with man than even a single century ago. Love to God and love to man, on the authority of Christ, the Lord and Savior of men, possess the minds and hearts of Christians with an intensity undreamed of a hundred years ago.

SIR JOHN FRANKLIN.

[Born 1786. Died 1847.]



No mildness of the Arctic summer dawned to release the imprisoned ships that carried to their doom the crews of Franklin and Crozier. The ice, having closed upon them, held them fast; and the unhappy voyagers, conscious of their peril, but undaunted by it, could but turn away into the wilderness, to mark each stage of their journey with a grave, and to find in those dim and untrodden wastes where the darkness of Arctic winter is broken only by the weird glitter of the northern lights, that bourn whence no traveler returns.

CHAPTER XLIX.

ASTRONOMY.

HERSCHEL—NEW LENSES AND TELESCOPES—KNOWLEDGE OF COMETS—NEW PLANETS—THE SOLAR SPECTRUM—STELLAR PHOTOGRAPHY—LEVERRIER—FLAMMARION—THE GREAT ASTRONOMERS.

A HUNDRED years ago, owing to the proverty of astronomical instruments comparatively little was known of the sizes, distances and velocities of the heavenly bodies. The real founder of sidereal astronomy was Sir William Herschel (1738-1822) who remains greatest as well as first of all the "star gazers." Educated a musician, he began the manufacture of optical instruments at twenty-eight, and produced several excellent telescopes. He discovered the planet, Uranus, which ought to bear his name—and later two of its satellites, as also two of the satellites of Saturn. Appointed royal astronomer he produced his great telescope, with which he resolved the milky way into more than twenty millions of visible stars. Among his discoveries are that the stars are suns, each the center of a solar system, that the "nebulous patches" in the sky are stars; that the binary stars revolve around a common center of gravity; that our solar system is moving toward another part of the sidereal system; that the stars decrease in number from the milky way, etc. He added nine members to the solar system, to the eighteen previously known. He ascertained in 1803 the diameter of Alpha Bootis, though he only saw it once through a fog two-tenths of a second! The Herschel family are forever associated with the stars.

A TELESCOPE OF 1830.

John Frederick, son of William (1792-1871) was his father's legitimate successor, and carried astronomical science far along, and strengthened and increased the broad foundations already laid. Caroline Lucretia Herschel (1750-1848) the sister of William, was his devoted assistant for almost half a century.

At the beginning of the century a few small telescopes were exploring the heavens, and obtaining only meager results. To-day, there are many of enormous size and power, that are constantly making discoveries that had been deemed impos-

sible, and were impossible with the best glasses then made. William Herschel and his sister, Caroline, were the great manipulators of the telescopes of that day, and their united observations and investigations contributed immensely to the fund of astronomical knowledge. In 1817 Fraunhofer perfected an object glass of great excellence.

The greatest telescope up to the end of the first half of the century was Lord Rosse's, completed in 1845, with a speculum six feet in diameter, and fifty feet focus.

Wonderful progress has been made within a few years in the production of lenses. The manufacture of glass was so little advanced that only lenses four inches in diameter had ever been produced before the year 1800. The first to make the improvements that have resulted in such great instruments as are now in use was Pierre Louis Guinaud (1745-1824). He was apprenticed to an optician, and after 1785 he devoted all his skill and energy to the manufacture of lenses. His telescopes, every part of which was his own work, became famous. His sons continued their father's work. In 1840 William Lassell (1799-1880) applied the equatorial mounting to the telescope, by which the glass follows the revolution of the sky. The circles continued to be improved until they attained perfect accuracy. Alvan Clark and sons, of Cambridge, Mass., have produced some of the finest lenses ever made. Hall, in 1733, and John Dollond (1706-1761) in 1758 found that the color could be eliminated, and the telescopes rendered nearly achromatic by making the object glass of two lenses; but large disks were not cast until 1840, when French glass makers were able to produce them. Since then improvements in glass making have been made until achromatic lenses are now nearly perfect.

The Yerkes telescope, the gift of Mr. Charles T. Yerkes to the University of Chicago, is one of the largest refracting telescopes in the world. The column and head, of cast iron, rise to a height of 43 feet, and weigh 50 tons. The tube is of steel, 64 feet long, and 52 inches in diameter at the center, tapering toward the ends. Its weight is six tons. The lens is forty inches in aperture. The driving clock, weighing one and one-half tons, is located in the upper section of the column. It is wound automatically by an electric motor and is controlled by a double conical pendulum. It is geared to the main driving wheel, eight feet in diameter, which, when clamped to the polar axis revolves it, together with the tube and all its accessories — all weighing twenty tons — in exact sidereal time. The total weight of the telescope is seventy-five tons. The site chosen is Williams Bay near Lake Geneva, Wisconsin, in order to avoid the smoke and other atmospheric impurities which prevail in Chicago and its immediate vicinity. Dedicated in 1897—Prof. George E. Hale, director.

It cost $70,000 to grind the lens of the Yerkes telescope.

Other remarkable American telescopes are those of Lick Observa-

, with an aperture of thirty-six es; Yale University, twenty- t inches; United States Naval, nty-six; Leander McCormick, nty-six; Princeton, twenty-three; ver, twenty; Smithsonian, nty; Dearborn, eighteen and one- ; Carleton College, sixteen and tenths; Warner, sixteen; Wash- on, fifteen and one-half, and vard, fifteen. The largest re- ing telescopes are those of Harvard College, twenty-eight es, and of the Rev. Dr. John te, twenty-two inches. Though Yerkes and Lick are the largest scopes at present, Harvard Col- has the best equipped observa- for general astronomical work merica and one of the best in the ld. Other notable telescopes are: ty-inch objective for the Alleg- y University; the Lowe tele- e, thirty-seven and one-half es, for the Lowe observatory, thern California; the new Cham- ain conservatory telescope (Den- Col.), thirty-eight inches. Prof. rge A. Fargis, S. J., of the George- n College Observatory, has pro- d an instrument that is attached he telescope recently completed Georgetown College, that regis- the time of the transit of the s.

he new telescope to be used at Paris Exposition this year (1900) bring the moon within forty s.

he Barlow lens is a modification he object-glass of a telescope, gested by Mr. Peter Barlow 6-1847) with the idea of avoiding use of flint glass in the construction of object-glasses of large size; disks of flint glass suitable for optical purposes then being both expensive and rare. He proposed to enclose between two convex lenses a fluid lens equal in refractive power to a flint glass of the same dimensions. Also a concave lens inserted in the eye-piece of a telescope before the rays come to a focus, by means of which the focal length of the object glass or speculum is increased nearly one-half, and the effect is the same as if the tube were proportionately lengthened, the magnifying power being considerably increased. Another advantage of the Barlow lens is the avoidance of the loss of light which would take place if the same magnifying power were produced by using an eye-glass of shorter focus.

A great modern improvement in telescopes is the work of Louis Gathmann, of Chicago, who is author of several other useful inventions. An ordinary refracting telescope is made of two objective lenses, of the same size, but of differently shaped surface and composition of glass. One is of crown, the other of flint glass. These two kinds of glass are used for the purpose of removing the prismatic colors which obtrude in a single lens and give an indistinct object for each color, instead of one clearly defined object, as desired. So that when opticians or astronomers speak of the thirty-six inch lens of the Lick telescope, or the forty inch lens of the Yerkes, they really mean the two lenses—the one of crown, the other of flint—that go to make up what is spoken of

as the objective lens of an achromatic refracting telescope. Now, by the Gathmann method, the crown and flint lenses are used as in the ordinary method; but, instead of the lens being thirty-six inches or forty inches in diameter, it is made by filling up a diameter of 36, 40, 60, 70, or even 100 inches, as desired, with a large number of smaller lenses, all made of good, clear glass, and ground to one common focus. The small lenses may be many or few, large or small, or both together; they may be round, oblong, octagonal, or square, or all combined in one telescope. The only necessity is that they shall all be ground to a common focus. Any microscopical student of the eye of a fly knows that it is composed practically of 2,000 separate lenses, but all working in perfect harmony to produce clearest light and sight for the insect. So the Gathmann telescope, composed of any number of lenses, all refracting to a given focus, simply patterns after that which Nature has been doing for centuries.

In 1850 American astronomy devised the Chronograph, which records the transits of the heavenly bodies.

COMETS.—The knowledge of comets has been immensely increased during the century. In fact they were previously regarded with terror by multitudes of people, and their character was entirely unknown by the learned. They were supposed to presage war, famine or pestilence, and it was thought that some time the earth would be annihilated by contact with one. Who that has passed three score years does not remember the terror with which even intelligent people regarded the appearance of a comet, or the fall of a meteoric shower? They were dire portents until the telescope resolved them into harmless phenomena.

More than 600 comets, according to J. R. Hind (1825), have been found, but Prof. Lewis Swift thinks about 17,500,000 exist in connection with the solar system. The head or nucleus is much less solid than it seems. Thus, in 1832, Sir John Herschel saw a group of stars only of the sixteenth magnitude, almost through the center of Biela's comet. When such a body might be expected to exercise gravitation, its influence is too small to be perceptible. Their orbits are, first, those whose orbits are so long that they are usually regarded as parabolas, and second, those whose orbit and period are both short. Of the latter class, about twelve or fifteen are known. The first seem to have come to us from outside space; the second set, originally belonging to the former, to have had their direction changed so as to produce their present short elliptic orbits by the action on them of some planet. In 1866 Professor G. V. Schiaparelli (1835), of Milan, discovered that the orbit of Tuttle's comet, the third which had appeared in 1862, was nearly identical with that of the August meteors, and Tempel's comet, the first of 1866, with that of the November meteor stream. In consequence of this discovery,

P. G. Tait (1831) published ew that the sudden develop- of tails, many millions of miles th, the occurrence of comets nany tails, and the observed at there is no definite relation ection between a comet's tail s solar radius vector, may be ted for on the supposition that et is a cloud of small masses, s stones and fragments of ic iron, shining by reflected alone, except where these impinge on each other, or on matter circulating around the nd thus produce luminous along with considerable mod- ns of their relative motion. ifferences of motion of the ic fragments relatively to the present appearances analogous e of a flock of sea birds flying plane, and only becoming as streak when the plane of the passes approximately through ectator's eye. The so-called pes surrounding them are red with the curling wreaths acco smoke emitted from a In 1864, Donati, and in 1868 881, William Huggins (1824), ned the bright comet then in ky with the spectroscope. ing this to be similarly com- to other comets, he came to nclusion that part of their s reflected sunlight and part al light, and further, that car- present in the cometary mat- n the first quarter of the cen- . L. Pons (1761-1831) discov- hirty comets, and since then n, G. B. Donati (1826-1873), rope, and Swift, Brooks and Barnard, in America, and other comet-finders, have caught a large number of these wanderers of the skies.

PLANETS.—Says the "American Cyclopædic Dictionary:" "Prof. Titius, of Wittenberg, having drawn attention in 1772 to the fact that, with the exception of Jupiter, each planet has an orbit just about double that nearest to it on the side of the sun; Prof. Bode, of Berlin, drew the natural inference that the one exception to the rule would probably be removed by the discovery of a planet less remote from the sun than Jupiter, and more distant than Mars. A society was formed in 1800 for the special purpose of exploring the zodiac with the hope of discovering the supposed planet, but its efforts were not crowned with success. The century auspiciously opened with the discovery of a planet. On the first day of the present century (January 1, 1801) a planetary body, or planetoid, afterward called Ceres, was found by G. Piazzi (1746-1826) in the part of the solar system theoretically indicated; it was, however, far more diminutive in size than had been expected. Within the next six years three more asteroids (Pallas, in 1802, by Olbers, Juno in 1804, and Vesta in 1807) were found in proximity to Ceres, and the suspicion arose that a goodly-sized planet had either been blown to pieces by internal forces of an explosive character, or splintered in a collision with some other heavenly body. Sir D. Brewster boldly affirms this in his edition of 'Ferguson's Astronomy, while Sir J. Herschel at one time

ridiculed the idea. It was reasoned that if such a catastrophe had taken place, many more than four fragments of the shattered planet would probably exist; but the search having been considered futile, it was abandoned in 1816. It was subsequently resumed by M. Hencke, and from 1845 to July, 1879, no fewer than 200 have been met with. All are of minute size, and some angular in place of spherical. According to Daniel Kirkwood (1814), astronomer, they would collectively make a planet only a little larger than Mars."

The term asteriod, applied to these small bodies, is now becoming obsolete, the appellation minor planets taking its place. Planetoids is another name. They are sometimes also called extra-zodiacal planets, from their orbits stretching outside the zodiac, which is not the case with those of the normal type. Authorities differ respecting some minute points in the list of asteroids. Before the century began there were but five planets known; now there are 443 small planets and planetoids that have been discovered during the century—the last in February, 1899. In 1807, Pallas, Juno and Vesta were discovered, and in 1845 the fifth. There are now in all nearly 500. Of these seventy-five were discovered in this country by Peters; twenty-two by Watson; Palisa in Vienna, seventy-two; Wolf, of Heidelberg, sixty; Chanlors, of Nice, ninety. There may be thousands yet to appear.

The discovery of Neptune is declared by Sir David Brewster to be the "most remarkable in the history of physical astronomy." Astronomers had long believed that the perturbations of Uranus must be due to the disturbing influence of another invisible planet. A. Bouvar (1767-1843), Hussey, P. A. Hansen (1795-1874), and others so insisted. In 1846 Bessel endeavored to locate the spot where it should be found, but his death stopped the inquiry. Meanwhile two young astronomers, J. C. Adams, of Cambridge, England, and Leverrier, of Paris, were pursuing the investigation, and Adams assigned its location. Prof. Challis directed his telescope to the spot indicated, and the planet appeared a little more than a degree from the place assigned for it. It revolves around the sun in 172 years, and its discovery extends the solar system 1,000,000 miles beyond its former theoretical limits. "It is," says Sir David Brewster, "the greatest intellectual achievement in the annals of astronomy, and the noblest triumph of the Newtonian Philosophy." Sir David adds: "The honor of having made this discovery belongs equally to Adams and Leverrier."

Before Herschel discovered Uranus, in 1781, but five planets were known, but in 1801 Ceres was discovered and three others four or five years later. In 1845 and 1847 two others were announced. Every year since 1846 new asteroids have been discovered. Down to 1885, 250 are to be traced between Mars and Jupiter. The orbits of these bodies reveal an intricacy of movement

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A MODERN INTERIOR.

that only infinite wisdom could plan and operate.

In 1847 a moon was discovered belonging to Neptune, in 1848 an eighth, and in 1899 a ninth satellite of Saturn was discovered. In 1877 Mars was seen to have two moons, Jupiter is now known to have five moons.

The discovery of Ceres, by Giuseppe Piazzi is interesting. January 1, 1801, he noticed a star, which had moved on the next evening, and which he found to be a new planet. The day after its discovery appeared a philosophical essay from Hegel, demonstrating that there could be but seven planets!

Seven satellites have been added to the planets, four of which were discovered by American astronomers. When Néptune was discovered Sears Cook Walker (1805-1836) determined its orbit and was able to trace back its movements in the heavens for half a century and show that it had been observed as a fixed star by J. J. S. Lalande (1732-1837) in 1795 without the observer suspecting its character. It was not until Friedrich Wilhelm Bessel (1784-1846) began those investigations that resulted in discovering, in 1840, the parallax of the star Cygnus, and later the parallax of the fixed star nearest to us, Alpha Centauri, was announced from observations at the Cape of Good Hope. He discovered the process of measuring the distances of the stars. These were almost the first of that long procession of discoveries that astronomers have made, and announced, all within three-fourths of a century. Barnard, in 1892, discovered a fifth moon of Jupiter.

Astronomical Photography (see "Photography") is a marvelous achievement of recent years. Not only are all the phases of the heavenly bodies caught and preserved, but so much more sensitive is the camera than the human retina, that stars are discovered and shown by it that no telescope brings within the range of human vision. Warren De La Rue (1815-1882) accomplished the first important results, though Dr. John W. Draper (1811-1882) daguerreotyped the moon, and Bond caught Vega and Castor, in 1845. In 1853 De La Rue photographed the moon, and in 1857 he constructed at Kew a photo-heliograph—a small telescope with plate holder, and the process of photographing the sun was begun, and has since been continued all over the world. In 1861 De La Rue took a stereoscopic view of a sunspot. Since then every change in the sun's appearance, and many of the countless changes of the heavenly bodies, have been recorded by the unerring lens.

Photography was first employed in picturing eclipses, July 18, 1860, by De La Rue, with his photo-heliograph, and in 1868 eclipse spectroscopy was first applied. The most careful observations have been made and rich results obtained, that have greatly advanced human knowledge.

In 1899 W. H. Pickering discovered a new satellite of Saturn on a photographic plate received from Peru. The last one before this was

discovered in 1848, by Professor Bond, in Cambridge.

The value of photography to astronomy, is more and more manifest from year to year. Whipple and Bond took the first chemical star pictures in 1845. In 1840 the moon was first photographed; in 1850 a star, in 1851 the sun's corona, in 1854 a solar eclipse, in 1872 a star spectrum, in 1880 a nebula, in 1881 a comet, in 1891 a meteor,—all but the meteor and the corona were produced by Americans.

The spectroscope is an instrument that reveals the constituents of the celestial bodies. Sir Isaac Newton had laid the foundation of the knowledge revealed in spectrum analysis, when with a prism he separated the white solar ray into the seven-hued solar spectrum. In 1802 W. H. Wollaston (1766-1828) made further discoveries, and in 1814 J. Fraunhofer (1787-1826) added the telescope to the prism, and found that there were some 600 lines visible. There are known to be many thousand lines in the spectrum — "Fraunhofer's Lines," which he generalized, were causad by the constituent elements of the bodies inspected. Further investigations by Sir David Brewster, Sir John Herschel and other scientists, showed that the materials of the sun and stars can be ascertained by the spectroscope, which was invented by Kirchoff and Bunsen, and subsequently improved by others. But this fact was not learned until discovered by Kirchoff in 1859, though scientists had been groping for it from 1814. Norman Lockyer, in 1866, Doctor Huggins, in 1861, Angstrom and other savants have ascertained through spectroscopic investigation that the sun, stars and planets are composed of the same elements and governed by the same laws that characterize our earth. So that it may be said that not only have the stars that shine millions of miles away been brought almost to our own doors by the magnificent telescopes that this century has produced, but the spectroscope has made us acquainted with the very elements of which they are composed, and the laws that control them as they pursue their everlasting courses. Kirchoff discovered celestial spectrum analysis, and he and Bunsen terrestrial spectrum analysis, and thus the annals of stellar history are recorded from night to night. The founders of stellar spectroscopy are P. A. Secchi (1818-1878) and William Huggins (1824). We knew nothing of the constituents of other worlds than ours, until A. D., 1860. Kirchoff, Wollaston and Fraunhofer indicated the process of developing the principles of spectrum analysis, and Clarke, Rowland, Hastings and Brashear contributed the optical skill and mechanical dexterity that enable us to tell the exact constituents of the celestial bodies. Already forty elements have been detected in the sun.

In 1842 the profound philosopher, Comte, declared that it was a waste of time to study the fixed stars, as they were so far away that nothing can be learned of them, and yet within less than a score of years their very constituents were ascer-

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of astronomy and mathematics, are the names of Herschel, Laplace and Leverrier, and their labors shed unfading glory on the Nineteenth Century. Pierre Simon Laplace (1749-1827), in mathematical ability and attainments, was only inferior to Newton. Says the "American Encyclopædia:" "His discoveries of the cause of the discrepancy between the theoretical and observed velocity of sound, his rules for barometrical measurement, and his theories regarding capillary attraction, and atmospheric refraction, show that in some of the most important branches of general physics, his mind was not less active and profitably employed than in mathematical analysis. The crowning glory of his scientific career was his 'Mecanique Celeste,' a book which has been truly said to have had no predecessor, and which must wait for a second Laplace to arise ere it shall find a rival. In it he sought to digest, on a uniform scientific basis, the abundant materials relating to the application of analysis to physical astronomy, which has been so accumulating during nearly a century, and which, written in various languages, with differing notations and in various stages of scientific progress, presented a mass of matter not only difficult of access, but almost incomprehensible to any but the most recondite student. He was also the inventor of the calorimeter, which measures the capacity of bodies for heat. Laplace has no peer in the realm of mathematics during the century."

Mary Somerville (1780-1872) was the foremost scientific scholar among

the women of the century. She continued the most intricate calculations until she had passed her ninetieth year.

On Echo Mountain, near Pasadena, Prof. T. S. C. Lowe has established an observatory, which bears his name, where the veteran astronomer, Dr. Lewis Swift, "the comet finder," with his fine sixteen-inch refractor, in the clear atmosphere of Southern California, has penetrated many of the hitherto secret and unknown realms of space, and wrested therefrom new knowledge. For these achievements, Doctor Swift has received the coveted prize of astronomers, the Gold Medal of the Royal Astronomical Society of England, and has been placed at the head of the list of living astronomers by the savants of France.

One of the most notable examples of the constant, and yet almost imperceptible changes taking place in our firmament is to be found in the motions of the seven bright stars forming the "Big Dipper," in the constellation Ursa major. Dr. William Huggins (1824), the eminent English astronomer, has found by means of the spectroscope that five of these stars are moving in the same direction, with nearly the same velocity, and receding from the earth at the rate of about twenty miles per second, which seems to indicate that they are associated with each other in some mysterious way at present unknown to astronomers. Professor Richard A. Proctor (1837-1888), referred to them as the "drifting stars," and this community of motion, where groups of stars appear to be traveling as systems, he termed "star-drift," of which there are many interesting examples to be found in various parts of the heavens. After a careful and long-continued study of the motions of the seven stars in the "Dipper," Professor C. Flammarion (1842), a distinguished French astronomer, has been able to represent the outlines formed by them at various times in the past and those which they will form in the distant future. One hundred thousand years ago, according to his ingenious calculations, the stars now forming the familiar "Big Dipper," were arranged in the outline of a large and irregular-shaped cross; and one hundred thousand years hence they will assume the outline of an elongated and inverted "Dipper,"—very different from the one we now see—which will stretch over a large extent of the sky, and the two "pointers," now so convenient to casual observers of the heavens, will then no longer indicate the position of the "pole star," as they do at present, for there are no "fixed stars," and each one of those distant suns, flaming in the immensity of space, is swept along in a movement so rapid that the human mind can hardly conceive it, and almost grows weary even in its contemplation.—Professor Arthur K. Bartlett, in Chicago "Inter-Ocean," February 18, 1894.

The stars now seen by the best telescope are 50,000,000. The number able to impress a photographic plate is enormously greater. (See "Photography.")

e velocity of light was first ured by L. L. Fizeau (1819), a ch physicist, in 1849, and more ctly by Leon Foucault (1819- in 1862. The latter also dem- ated the rotation of the earth axis.

v sciences have made such pro- as has Astronomy during the nt hundred years.

ong those who have become ent since 1800 in the annals of nomy either in discovery or in larizing it, are George B. Airy -1892), Stephen Alexander -1883), G. B. Amici (1784-1863), Angström (1814-1874), D. F. o (1786-1853), Francis Baily -1844), George P. Bond (1825- , W. C. Bond (1789-1859), . Burnham, George Davidson), W. F. Denning (1848), Wil- Rutter Dawes (1790-1868), nas Dick (1772-1857), Johann cis Encke (1791-1865), Camille marion (1842), James Glaisher), B. A. Gould, Jr. (1824), John l (1804-1881), William Lassell -1880), G. R. Kirchoff (1824- , Asaph Hale, discoverer of moons (1829), George E. Hale, nas Henderson (1798-1844), J. Hurd (1823), E. S. Holden), J. L. La Grange (1736-1813), L. Lalande (1732-1807), P. S. ace (1749-1827), J. W. Lubbock -1865), O. M. Mitchell (1809- , Maria Mitchell (1818-1889), ewcomb (1835), Heinrich W. M. rs (1758-1840), John Pond -1836), J. L. Pons (1761-1831), . Proctor (1837-1888), P. A. ni (1818-1878), Mary Somer- (1780-1872), Johann Hieronymus Schröter (1745-1816), L. M. Rutherford (1816), F. W. Struve (1793-1864), L. Swift (1820), D. P. Todd (1855), S. C. Walker (1805-1853), C. A. Young (1834), etc.

Professor G. W. Hough (1834), of Yerkes Observatory, is the inventor of the automatic printing chronograph, which has been considered the most useful astronomical invention next to the telescope. Among his other inventions are: a cataloging and charting machine for making maps of stars automatically, an automatic registering and printing barometer, an automatic registering and printing anemometer, a registering chronograph, an observing chair, which, on account of its cheapness and simplicity has been introduced into all the observatories of the country, and an absolute sensitometer. The spectro-heliograph, designed by Hale, about 1890, photographs the prominences on the sun.

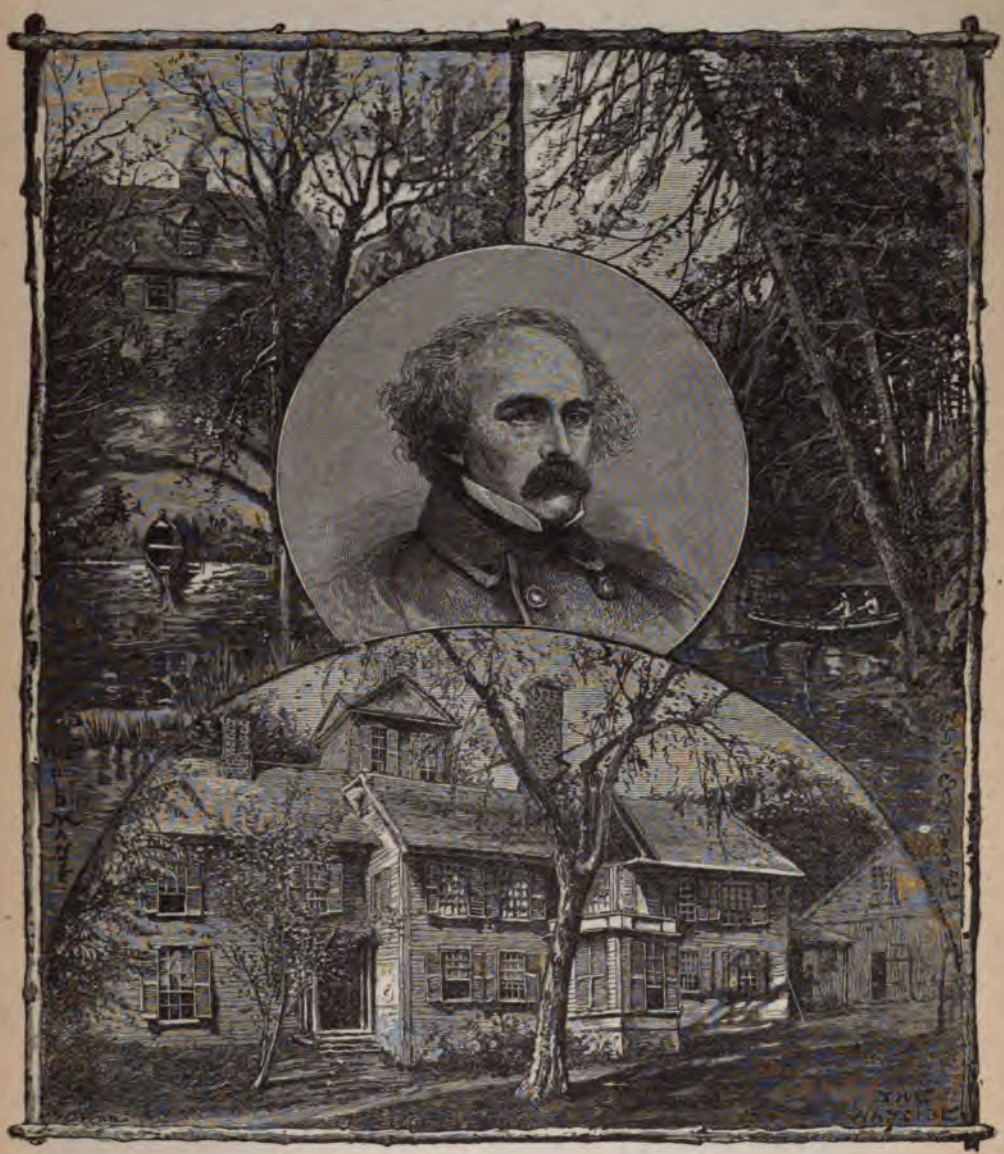
The wonderful improvements in telescopes, the aid of photography, and spectrum analysis, have not only already vastly increased our knowledge of the heavenly bodies, but have opened avenues along which the astronomer may travel in succeeding centuries. To Wollaston, in 1802, Fraunhofer, in 1817, and Kirchoff, in 1860, and their successors, we owe an almost infinite debt.

Immense as has been the progress of astronomy during the century, it is apparent that the celestial science is just on the frontiers of far greater advances. The improved and constantly improving telescopes; the spectroscope; stellar photography

and its manifold appliances; the establishment of posts of observation in the most favorable mountain localities in all parts of the world by the great institutions of learning, so that simultaneous observations can be made, and the results compared; all these and other facilities must give to the Twentieth Century a vast superiority over the Nineteenth. Should this book survive, let not the scribe who shall tell the wonders of that favored period smile at our exultation over the accomplishments of this most fruitful century.

NATHANIEL HAWTHORNE.

[Born 1804. Died 1864.]



There is probably no writer whose personality seems to us so largely mingled with his productions as Hawthorne's. In truth, the man and his work are inseparable in our minds. Sometimes he seems merely repeating to us the things he has seen in his visions, for he is as ever as one who dreams dreams and sees visions; then again his intellectual and moral insight is so like one laying bare, under great stress of circumstances, the inmost secrets of his own heart.

CHAPTER L.

EDUCATION.

TIONAL PROGRESS ALL OVER THE WORLD—COMMON SCHOOLS—POLY-CHNICS—KINDERGARTEN—STENOGRAPHY—CORPORAL PUNISHMENTS OBSO-SCENT—THE ERGOGRAPH.

E progress of education in Europe and America is one of he great triumphs of the cent- ost of it has been within fifty From little or no educational ges great advances have been until the following status is l in Europe:

ria-Hungary. — Compulsory, 849, between six and twelve of age. Compulsion fully out only in Germanic por- f the empire. Supported by al and local taxation.

nark. — Compulsory from to fourteen; poor children gratuitously.

ce.— Compulsory and free. ted and directed by govern- t a cost of $32,000,500. Thirty nt. of population above six to read.

nany.— Compulsory, and al- niversal. Supported by local nd governed locally. All the s of 1890 could read except 0.5 t.

t Britain.—In England free in nine per cent. of the schools; land, altogether free; in Ire- ree up to 6s. per scholar. Ex- ure (1892) for Great Britain eland, including fee grants ,000.

Italy.—Considerable progress has been made during the last twenty-five years. The attendance has increased by eighty per cent. In 1881 the percentage of illiterates over twenty was: males, 53.9; females, 72.9. Public money applied to education, $12,500,000.

Netherlands.—Compulsory since 1878. Expenditure by the state and communes, $6,500,000. Ninety per cent. of the children are at school. In 1890 7.2 per cent of the conscripts could neither read nor write.

Switzerland. — Compulsory. Attendance in Protestant cantons, one in five; in mixed cantons, one in seven; in Roman Catholic cantons one in nine. Of the recruits in 1890, only 0.17 per cent. were illiterate.

Russia.—Government expends on education about $22,500,000; of this only $2,250,000 on primary education. Only two per cent. of the population are at school. In 1888 only twenty per cent. of the recruits could read and write. In Finland the whole population can read.

In this country the common school system is the glory and foundation of the republic, reaching the young of all conditions in life. Besides these are innumerable academies, colleges and other institutions of learning

public and private. Before this century began there were practically no common schools in this country, and educational facilities were most meagre. Henry Clay learned to write by tracing letters in a box of sand with a pointed stick. Daniel Webster plucked his pen out of the wing of a goose, and made ink out of the soot of the fireplace. Girls could not attend public school in Boston till 1822, and then only in summer, when there were not boys enough to fill the seats. Now co-education is well nigh universal in this country, while colleges for women afford every advantage that the other sex enjoys.

As lately as 1834, in our own school days, each scholar had a grade of his own, as he rose and fell in the daily competitions of the spelling class. And the punishments were varied by the ingenuity of the teacher. The strap, the rattan, the cowhide, raising the culprit by the collar and the rear of the trousers, and plunging the nose into the inkwell, and various other devices were resorted to, among which "sitting with the girls" was the least painful, and which some of the boys were used to call "capital punishment." Terror was the rule, and corporal punishment the penalty of bad deportment or a defective memory. The first attempt we personally knew to govern the school by love and not by fear, was in 1835, in Lowell, Massachusetts, by Jacob Graves, who had the best school we then had ever seen. In whatever sphere the good man's spirit may now dwell, we give him our grateful thanks for having found the way to our own youthful heart.

"The educational condition of the English people in 1800 was very defective. The means of education were utterly inadequate to the wants of the nation. At the beginning of the century there was no more than 3,363 schools, public and private, in all England. In 1850 there were 45,000. In 1818 it was found that more than one-half of the children were growing up without education. A few years after it was noticed that of all persons who came to be married, one-third of the men and one-half of the women could sign the register. In the manufacturing districts it was still worse. Forty per cent. of the men and sixty-five per cent. of the women were unable to write their own names. The weaving population, in the collapse of their fortunes, which occurred after the close of the war, lost the power to bestow education on their children. And, besides, child-labor had grown to be an important source of revenue to poor parents. What hope did the child have to be educated when the dissipated and the poor could earn money by his labor from the time he was six years of age? England had fallen into an abyss of ignorance, her rescue from which is a bright page in the annals of the succeeding generation."

The British School System of education, the Lancasterian, originated with Joseph Lancaster (1778-1838), about 1808. In 1811 the National Schools were established in Great Britain, on the Madras system, originated by Andrew Bell (1753-1832).

In 1800 the belief of the educated was that education was not for the masses, and with the exception of private schools, academies and colleges, free education could only be had on a confession of pauperism. Free public schools were not in existence in this country until the century was well advanced. In the Southern states, the century was nearly half completed before common schools were established.

After they were well founded, they were not universally enjoyed until the celebrated Horace Mann (1776-1859) in 1833 enlisted his great genius in their behalf. He deserves mention as one of the greatest of those who have promoted the cause of education.

Polytechnic Schools.—These are educational establishments in which instruction is given in many arts and sciences, more especially with reference to their practical application. The first polytechnic school was established by a decree of the French Convention, on February 13, 1794, and was of great service to the country, but they did not become numerous until the present century came in. Numerous schools of this class now exist in all parts of the United States, and are known also as manual training schools. They are instructing would-be teachers, and the schools of the land are profiting by their work. It is a great contrast to the old teaching, when the verbal memory, not the observing and reasoning faculties, was the subject of cultivation, and the correct reciter of a form of words was supposed to understand them.

Stenography, or shorthand, did not become a science until the present century. In 1812 Lewis invented a method; in 1823 Harding announced an improvement on Lewis's, and Moat presented another in 1833. But the most successful and best system is Isaac Pitman's (1813-1897), Phonography, invented in 1837, based on the sounds of the English language. The alphabet contains six long and six short vowels, five diphthongs, and twenty-four consonants, or forty-one letters in all. Hooks and circles at the beginning and end of the consonant strokes, make double and treble consonants for abbreviating the writing.

The Kindergarten is one of the wisest of the beneficences of this century, originated by one of the profoundest students of human nature, and one of the wisest of the world's philosophers. A system of education for infants and young children, devised by Frederick Fröbel (1782-1852), by whom, in conjunction with W. Lange, it was first carried out at Hamburg, in 1849. In 1858 Lange published a work on the subject. Knowledge is imparted in an attractive form, chiefly by simple object-lessons, by toys, games, singing and work—plaiting, weaving, folding and cutting out paper. Corporal punishment is excluded. The chief merit of Fröbel's method appears to lie in the fact that he makes education a real drawing-out, not a mere imparting of instruction, which he considers as a means, not an end; his object is the unfolding of the child's whole nature, with a view to

free self-development and action. The kindergarten system is becoming increasingly popular in this country.

The most hopeful of all charities are those which elevate the very young. Every community stands under a moral obligation to give to every helpless child born within its borders the best possible chance to grow into honesty and virtue. The expense to the community of prevention will be far less than that of any attempt at care, in all the moral diseases caused by the poverty, ignorance or vicious surroundings of its young children. This evident truth was not discovered until Fröbel saw and announced it, and so laid the foundation of the most perfect system of education the world has ever seen. The poorest children in a community now find the beneficent kindergarten open to them from the age of two and a half to six years. Too young heretofore to be eligible to any public school, they have acquired in their babyhood the vicious tendencies of their own depraved neighborhoods; and to their environment at that tender age has been due the loss of decency and self-respect that no after-example or education has been able to restore to them. The kindergarten comes, in these helpful, later days, to these moral standings with sweet attractiveness, happy employment, wise development and instruction for little heads, hands and hearts, and with many a motherly lesson in cleanliness and those heretofore undreamed of amenities of life, out of which we may hope, in some far day, may be evolved, "Peace on earth, and good will to men."

The kindergarten is being made a part of the common school system, and it is one of the beautiful children of the Nineteenth Century. The kindergarten has been in more or less vogue for thirty years, perhaps; but the methods of Fröbel, the inspirer of them, were founded upon those of Pestalozzi, the Swiss educator, who developed them quite early in the present century. It was very long, however, before Frœbel's educational system came into vogue. Yet it was the natural system, applicable to all teaching, things before names—from the known to the unknown—from the particular to the general, from what we can see or know to what we cannot see or know, but which we may infer from description and comparison.

The system develops the original capacities and inborn abilities, by a carefully graduated and connected progress. In the form of play at first, the physical, intellectual and moral faculties are trained.

The principles of the kindergarten are applicable to all classes of children in all ages. It is an organic part of a complete system of juvenile education, to be applied in all schools and colleges. It is the greatest educational discovery of the century—perhaps of all the centuries. Former educators tried to learn what the teacher can do for the child. Fröbel seeks to make the child its own most powerful agent in its mental and moral awakening. "Education is a

: of growth, carried on by and ıgh the child." Play is syste- zed, and made to accomplish self- lopment. Prompted by kinder- en methods, and inspired by ›el, education has advanced dur- :he last twenty years more than . century before.

ıe principles applied by Fröbel ıe kindergarten were intended ıim to be, and are fast being, ied to all stages of education. :hat is true in the Fröbelian and Pestalozzian philosophy is appli- e to all classes of children in all . He transformed abstract prin- ›s into realities, and crystallized ls into a practical system.

ıild-study lies at the foundation he kindergarten,—how to make child the chief agent in its own lopment. "In the children lies seed-corn of the future."

'öbel's great work, "Education of ," which appeared in 1826, was greatest step forward ever taken lucation. Pestalozzi had shown children should be educated in ıcy, and infant schools were blished; but Fröbel announced great truths of his system, and irst kindergarten was opened in sia in 1840, but in 1851 the Prus- government disallowed the sys- In 1854 the system was intro- d into England; in 1855 into ıce; in 1873 into the United es. Fröbel was aided by Henry gethal and William Middendorf. step in education has made such ress as has the kindergarten.

ıere were more than 15,000,000 ls in the common schools of the ted States in 1898, and 400,000 teachers. In 1816 there were thirty-seven colleges; now nearly 500.

One distinct mark of progress in education is the abolition of corporal punishment in schools, in most of the United States. Some of the states, as Washington, impose a fine on the teacher who inflicts corporal punishment. In other states a teacher who whipped a child would be discharged by the board of education.

Whipping is yet practiced in England, but in other countries it is going out of favor. In France it is prohibited; there are various regulations in the different German states. Norway and Denmark regulate the age at which such punishment may be administered.

The reform was inaugurated in New York City in 1870, when its board of education passed a rule forbidding the use of the rod. One by one the states followed the example, until nearly all followed the same practice, although now and then there is an exception. Only a few years ago in the public schools the teachers always flogged unruly pupils. Children were strung up by the thumbs, sometimes they were flogged until the blood spurted from their poor backs, and in more than one case death was due to the punishment that the teacher believed necessary for the enforcement of discipline.

It was a common sight a few years since to see a little boy or girl writhing under the lash of some brute of a teacher, who, nine cases out of ten, was giving indulgence to temper

without thought of doing the child any good. The excuse was that a child was incorrigible. To-day teachers do not resort to corporal punishment, nor will they admit that any child is "incorrigible," for it is realized that a teacher should be able to control pupils by other means than force. Both in schools and prisons incorrigibility is rarely admitted, and when it is kindness and not cruelty is the corrective. The vast improvement in the discipline of schools justifies the change of treatment.

Schools were never so numerous and strong. The great state universities, the ancient and modern colleges, the public and private educational institutions of all grades are attended by thousands. Educational facilities were never so numerous and great, nor were they so improved as now. Benefactions from the wealthy and generous have been among the grandest gifts of the great givers.

Dr. W. T. Harris (1835), United States Commissioner of Education, cites the following statistics: In 1876-7 the enrollment in the schools of the Southern states was 2,472,107, a little more than fourteen per cent. of the whole population (white and colored included); five years later the ratio had risen to seventeen per cent.; in 1892 it reached twenty-one and one-fourth per cent., and, despite the fact that the five years following were years of special business depression, a further advance was made. In 1897 the total enrollment was 5,398,076, or twenty-one and one-third per cent. of the population.

The appropriation of one-sixteenth of the national domain to the establishment and support of free schools in the Western states gave the proceeds of almost 70,000,000 acres to that beneficent purpose. One of the commonest sights of the traveler is to see from the railway train a magnificent school-house, when as yet it seems almost the only building in the landscape. One-fifth of the entire population of the United States are school children.

The first seminary for women in this country was established in 1836, in Mount Holyoke, Massachusetts, by Mary Lyon; the next in 1839, in Macon, Georgia. The first genuine college for women was founded by Matthew Vassar, in 1861, in Poughkeepsie, New York. Girton College, in England, was established in 1869, and Newnham in 1873.

Co-education began in Antioch College, Ohio.

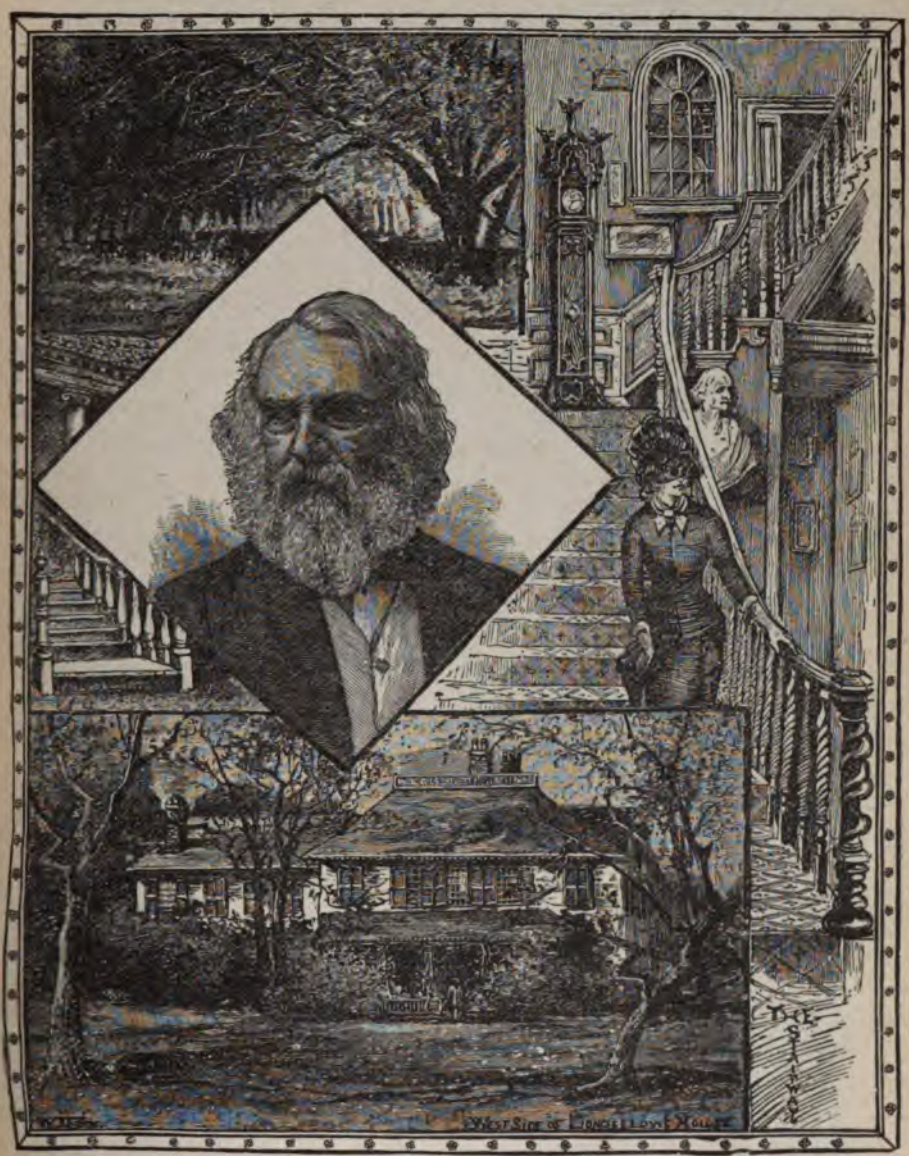
University extension began in England, in 1872; in this country in 1890, by means of which it is possible for those who cannot attend college to enjoy the advantages of a college course.

The colleges and universities of this country have been multiplied more than twelve-fold since 1800, and their grade has been vastly elevated. In 1800 a college was but little better than a high school.

A great aid in education is the Ergograph, a machine which makes a thorough physical-psychological test so as to ascertain a child's physical and mental ability.

HENRY W. LONGFELLOW.

[Born 1807. Died 1882.]



Longfellow is the poet whom all the world understands. He is no mystic, no seer. His calm philosophy always teaches some worthy or enduring lesson. Even the rude Village Blacksmith becomes, under his hand, an exemplar of human effort. His themes are as simple as his language is the perfection of melody and grace. If the right word is always a power, then may this poet's exquisite gift of language well stand for what is highest in the art of communicating one's ideas to others.

CHAPTER LI.

LITERATURE.

:YE VIEW OF THE LITERATURE OF THE CIVILIZED NATIONS—PRINCI-
L AUTHORS AND THEIR BIOGRAPHIES—A MULTITUDE OF THE GREATEST
ETS, NOVELISTS, ETC.

: reader who has reached the
llotted three score and ten,
an unroll the scroll of mem-
recall the first appearance of
ll the authors who now are
ed as great, in British, Ameri-
Continental European litera-
few, such as Shakespeare, Mil-
yan, Burns (who would have
the century had he lived to be
e), Johnson, Gray, Goldsmith,
per, antedated the century in
l; in this country almost no
f great ability had appeared,
h the exception of a scatter-
among the European conti-
nations, literature was an
nknown art.

ermore it may be said that
er of three score and ten
the appearance on the liter-
e of nearly every great writer
pe and America. He can re-
first appearance of Dickens's
rks in 1836-7; of Tennyson's,
ray's, Cooper's, in fact, of
all the authors of the first

Eighteenth Century had been
ished by many bright stars
literary firmament of Great
that yet shine with great
uch as Daniel Defoe (1661-1731), the author of the immortal "Robinson Crusoe;" Sir Richard Steele (1671-1729), Sir Isaac Newton (1642-1727), Jonathan Swift (1667-1745), Henry Fielding (1707-1754), Samuel Johnson (1709-1784), John Milton (1608-1674), Alexander Pope (1688-1744), Joseph Addison (1672-1719), Tobias Smollett (1721-1771), James Thomson (1700-1748), Oliver Goldsmith (1728-1774), William Cowper (1731-1800), Joseph Butler (1692-1752), Edward Gibbon (1737-1794), David Hume (1711-1776), Samuel Richardson (1689-1761), Edward Young (1684-1765), Thomas Gray (1716-1771), Mark Akenside (1721-1770), Edmund Burke (1730-1797), Robert Burns (1759-1795), Laurence Sterne (1713-1768), William Blackstone (1723-1780), and others of lesser light. It would indeed be difficult to find a more brilliant galaxy in any other century in any land. But with few exceptions those in the following century far surpassed them in brilliancy, while the number is vastly greater.

While the Nineteenth Century did not produce a supreme genius in literature, like Shakespeare, possibly not the equal of Robert Burns or John Milton—with the exception of

Goethe—yet in number and average authors, the product not only surpassed any preceding century, but all preceding centuries. What an array of novelists wrote in the cent-

CHARLES DICKENS.

ury just closing. The names of the principal ones in Great Britain alphabetically presented will be a surprise to the average reader: Grace Aguilar (1816-1847), John Aikin (1747-1822), W. H. Ainsworth (1805-1822), Jane Austen (1775-1817), James M. Barrie (1860—), A. W. a'Beckett (1844—), William Black (1841-1898), Walter Besant (1838—), Amelia E. Barr (1831—), Mary Braddon (1837—), Rhoda Broughton (1840—), R. D. Blackmore (1825—), author of the immortal "Lorna Doone;" Charlotte (1816-1855) and Emily Bronte (1819-1848), Frances H. Burnett (English born), Frances Burney (1752-1840), E. L. Bulwer (1803-1873), T. H. Hall Caine (1853—), S. R. Crockett (1862—), W. W. Collins (1824-1889), Mary Cowden Clarke (1809-1898), Dinah M. M. Craik (1826-1887), Charles Dickens (1812-1870), George du Maurier (1834-1897), Benjamin Disraeli (1805-1881), A. C. Doyle (1859—), Mary Ann Evans ("George Eliot"), (1819-1880), Maria Edgeworth (1767-1849), Amelia B. Edwards (1831-1892), E. C. Gaskell (1810-1865), E. H. Gates (1831—), A. S. Hardy (1847—), Thomas Hardy (1840—), Rudyard Kipling (1865—), Charles Kingsley (1819-1875), Caroline M. S. Kirkland (1810-1864), C. J. Lever (1806-1872), H. Kingsley (1830-1876), S Lover (1797-1868), F. Marryat (1792-1848), Florence Marryat (1865), H. Rider Haggard (1856—), Louisa de la Ramie, "Ouida" (1835), George MacDonald (1824—), Ian Maclaren (1850—), George Meredith (1828—), Mary R. Mitford (1787-1855), Amelia Opie (1769-1853), Jane Porter (1776-1850), Charles Reade (1814-1884), Susannah Ann Radcliffe (1764-1823), W. Clark Russell (1844—), Rowson

GEORGE ELIOT.

(1762-1824), author of "Charlotte Temple," Walter Scott (1771-1832), name sufficient to immortalize a century; R. L. Stevenson (1850-1894), William M. Thackeray (1811-1863),

ı Taylor (1817-1880), Jane Taylor 3-1824), Anthony Trollope (1815-), Mary Humphrey Ward (1851), ı Weston (——). Never in any ury, in any land, were novelists luced equal to Scott, Dickens, ckeray and Bulwer.

ar surpassing the brilliant array ovelists are the British poets of century: Sarah F. Adams (1805-), author of "Nearer my God to e;" W. Allingham (1828-1889), ed Austin (1835—), Edwin Ar- (1832—), W. E Aytoun (1813-), P. J. Bailey (1816—), Joanna lie (1762-1851), Anne L. Barbauld 3-1825), R. H. Barham (1788-), Robert Bloomfield (1776-1826), nard Barton (1784-1849), Wm. ce (1757-1828), W. L. Bowles 2-1850), John Bowring (1792-), R. W. Buchanan (1841—), abeth Barrett Browning (1809-), Robert Browning (1812-1889), d Byron (1788-1824), Thomas npbell (1777-1844), A. H. Clough 9-1861), George Crabbe (1754-), Allan Cunningham (1785-1842), a Cook (1817-1889), George Croly o-1860), S. T. Coleridge (1772-), Charles Dibdin (1745-1814), ıry A. Dobson (1840—), S. Dobell 4-1874), W. E. Henley (1849—), inald Heber (1783-1826), Felicia Hemans (1794-1835), James Hogg 2-1835), Thomas Hood (1798-), Mary Howitt (1804 - 1888), ıes H. L. Hunt (1784-1859), Jean elow (1830-1897), John Keats 6-1821), John Keble (1792-1866), ıes S. Knowles (1784-1862), Rud- l Kipling (1865—), E. Bulwer ton, "Owen Meredith" (1831- ı), L. E. Landon (1804-1838), Charles Mackay (1812-1889), Gerald I. Massey (1828—), J. C. Mangan (1803-1849), Geo. Eliot, poet and novelist, D. B. Moir (1798-1851), James Montgomery (1771-1854), Thomas Moore (1779-1852), William Morris (1834-1896), William Motherwell (1797-1835), Lewis Morris (1832—), Dinah Mulock (1826-1887), C. O. Nairne (1766-1840), C. K. D. Patmore (1823-1896), Caroline Oliphant (1766-1845), J. B. O'Reilly (1814-1890), William Praed (1802-1839), B. W. Procter (1787-1874), Adelaide A. Procter (1825-1864), Robert Pollok (1799-1827), Samuel Rogers (1763-1855), D. G. Rosetti (1828-1882), Christina Rosetti (1830-1894), Walter Scott (1771-1832), P. B. Shelley (1792-1822), H. Smith (1780-1849), Robert Southey (1774-1843), A. C. Swinburne (1837—), T. N. Talfourd (1795-1854), Alfred Tennyson (1809-1892), M. F. Tupper (1810-1889), William Watson, H. K. White (1785-1806), William Wordsworth (1770-1850), Charlotte M. Yonge (1823—).

It is only necessary to name some of the British authors in other departments of literature to suggest the wealth that has characterized the century. Among historians are Archibald Alison (1792-1867), E. A. Freeman (1823-1892), James A. Froude (1818-1894), J. R. Green (1837-1883), George Grote (1794-1878), Henry Hallam (1777-1859), A. W. Kinglake (1802-1891), Charles Knight (1791-1873), W. E. H. Lecky, T. B. Macaulay (1800-1859), H. G. Milman (1791-1868), James Robertson (1800-1887), Justin McCarthy (1830).

Among essayists and other writers are W. Bagehot (1826-1877), S. Baring-Gould (1834), F. J. Buckland (1826-1880), P. Bayne (1830), James Bruce (1838), Thomas Carlyle (1795-1881), Mary Cowden Clarke (1809-1898), Frances Power Cobbe (1822), Thomas De Quincey (1785-1859), T. A. De Vere (1814), Henry Drummond (1851), George H. Lewes (1817-1878), F. Galton (1822), W. S. Gilbert (1836), E. W. Gosse (1849), William Hazlitt (1778-1830), Charles Lamb (1775-1834), A. W. Kinglake (1809-1891), John Lubbock (1834), John Morley (1838), J. A. Symonds (1840-1893), J. S. Mill (1806-1873), W. H. Mallock (1849), F. W. Robertson (1816-1853), John Ruskin (1819-1898), Samuel Smiles (1812), Alfred R. Wallace (1822),—names unmatched in their realm by the writers of any age in any country. Not further to classify, consider Matthew Arnold (1822-1888), George Borrow (1803-1881), Dion Boucicault (1822-1890), H. T. Buckle (1822-1862), Alexander Bain (1818-1877), Lant Carpenter (1780-1840), Lewis Carroll (1833-1899), John Brown (1810-1882), Thomas Chalmers (1780-1847), Henry Drummond (1851), Charles R. Darwin (1809-1882), Thomas Dick (1772-1857), F. W. Farrar (1831), W. E. Gladstone (1809-1898), P. G. Hamerton (1834-1894), William Hamilton (1788-1856), James Hogg (1772-1835), Thomas Hughes (1823-1896), T. H. Huxley (1825-1895), Anna Jameson (1797-1860), Douglas Jerrold (1803-1857), Benjamin Kidd, John Kitto (1804-1854), W. E. H. Lecky (1838), W. S. Landor (1775-1864), Andrew Lang (1844), John G. Lockhart (1794-1854), H. Mackenzie (1745-1830), H. E. Manning (1831-1887), J. F. D. Maurice (1805-1872), Hugh Miller (1802-1856), F. Max Müller (1823), James Martineau (1805), Justin McCarthy (1830), George H. Lewes (1817-1878), Harriet Martineau (1802-1876), John H. Newman (1801-1890), John Stuart Mill (1806-1873), F. D. Maurice (1805-1870), E. Mulford (1833-1885), Richard Owen (1804-1892), William Paley (1743-1805), Sidney Smith (1771-1845), Goldwin Smith (1823), T. S. Smith (1790-1861), R. B. Sheridan (1751-1816), Herbert Spencer (1820), C. H. Spurgeon (1834-1892), R. C. Trench (1807-1886), John Tyndall (1820-1893), John Wilson (1785-1854), George Wood (1827-1889), John Walker (Dictionary, 1732-1807), and others mentioned in other parts of this book.

Walter Scott, the great magician, equally poet and novelist, and on the whole the best novelist who has written in the English language, did not manifest the rare genius with which he was endowed until his twenty-fifth year. "The Lay of the Last Minstrel" first notified the world of his abilities as a poet, and was followed by "Marmion" and other poems that delighted the world. In 1814, when he was forty-three, he published his first novel, which was followed in rapid succession by others, at the rate of six or seven volumes a year. Their wonderful plots, felicities of description, of character and nature, and healthfulness of spirit were new features in literature, and challenge the world's admiration. He rose rapidly to

wealth, and was in the enjoyment of the greatest prosperity and fame, when his publishers, Constable and Company, failed. Scott was involved to the amount of $600,000. He refused to compromise, and set to work to liquidate this enormous sum. He had achieved half of the immense task, when his mind began to give way, and he died in Abbotsford, at the age of sixty-one, unable to recognize his dearest friends. His works are yet among the most read and bid fair to retain their hold on the generations to come.

Alfred Tennyson (1809-1892), the poet-laureate of England from 1850 to 1892, is unquestionably the greatest poet of the Nineteenth Century, and his "In Memoriam" is the most perfect of his poems. It is indeed a monumental work that occupied seventeen years in its composition. His great compositions are household words wherever the English language is spoken. His religious views were hopeful in the extreme, and are expressed in his "In Memoriam:"

"Oh, yet we trust that somehow good
Shall be the final goal of ill,
For faults of nature, sins of will,
Defects of life, and taints of blood."

"That nothing walks with aimless feet,
That not one life shall be destroyed,
Or cast as rubbish to the void,
When God hath made the pile complete."

An English writer describes an interview with Tennyson in the following words: "The impression left by one conversation with him is still vivid in my memory. We were walking alone, up and down a long walk in the garden at Freshwater, and discoursing on a theme respecting which we were entirely at one, namely, the very limited nature of our knowledge, and how easily we deceive ourselves into the notion that we know many things of which the reality is entirely hidden from us. 'What we know is little, what we are ignorant of is immense.' While we were thus talking he stooped down and plucked one of the garden flowers beside the path. 'How utterly ignorant we are of all the laws that underlie the life of even this single flower,' he said. This line of thought was exactly the same as that which he expressed in the striking poem:

'Flower in the crannied wall,
I pluck you out of the crannies,
Hold you there, root and all, in my hand,
Little flower; but if I could understand
What you are, root and all, and all in all,
I should know what God and man is.'

"'But yet,' he said, 'this one flower, taken by itself, is quite sufficient to tell us all that it is most essential for us to know. It proves to us the love of God.'"

Charles Lamb, the quaint humorist and true genius, will always be known as "Elia," which he published about 1820. A slight stammer in his speech gave great point to his witticisms. The purity of his style and the rare quality of his humor are not surpassed by any English writer. His devotedness to his unfortunate sister, Mary, is one of the most pathetic episodes in the history of literary men. A story of greater self-sacrifice and nobler unselfishness could not be told. He had some faults; none knew them better than himself, and they are candidly

acknowledged in more than one of his essays. His place in literature no one can possibly dispute. He ranks with Addison, Steele, Temple, Shenstone, and Macaulay, and is equal to the best of them.

Charles Dickens, the greatest of England's novelists, unless Thackeray equals him, which he may have done in "Vanity Fair," but not in the fecundity of his genius, and his enormous range of plot and character, began his literary career with but faint promise of his future greatness. The writer of this sketch—then a young lad—remembers with what interest the "Sketches of Boz" appeared as a serial, and with what avidity they were devoured. And later "Pickwick" (1836), "Oliver Twist," at the same date, "Old Curiosity Shop," "Barnaby Rudge," and the other immortal works of the great genius were read as they appeared, with a popular interest that no other author has elicited during the last three score years. Nor does the interest in his works seem to diminish; in fact, the fame of Dickens brightens with the passing years, and he must continue for long years to come to be read with delight by all who love the best in English literature.

Thomas Hood, the prince of wits, has on his monument the words: "He sang the song of the shirt," and the same inspired genius wrote "The Bridge of Sighs," two poems that place him among the great singers of the world.

The literature of this country may be said to have been born and lived its entire life in this century. With the exception of Franklin's "Autobiography," and some of his minor productions, Brockden Brown's almost forgotten novels, the "Federalist," Edwards's theological works, Samuel Adams's political works, Paine's "Common Sense," "Rights of Man," and "Age of Reason," the several state constitutions, which are remarkable among political compositions, the constitution of the United States, which ranks above all other political compositions, Washington's "Farewell Address," and perhaps some other inferior productions, chiefly theological or political, the American writings of the two preceding centuries were mainly provincial, and justified the question, long since obsolete: "Who reads an American book?" Washington Irving (1783-1859) was perhaps the first author to render the question no longer pertinent. "Knickerbocker's New York," published in 1809, stands as a unique literary achievement, in the department of humor, while his more serious works are written in an English whose purity has never been surpassed.

Among the humorists are Charles Farrar Browne (1834-1867), ("Artemus Ward"); Robert J. Burdette (1844); Samuel L. Clemens (1835) "Mark Twain"; George H. Derby (1823-1861) ("John Phoenix"); Thomas C. Haliburton (1796-1865), author of "Sam Slick"; Marietta Holley, "Betsey Bobbett," 1812; David Ross Locke (1833-1888), "Petroleum V. Nasby"; James Russell Lowell (1819-1891), "Bigelow Papers"; R. H. Newell (1836), "Orpheus C. Kerr"; Edgar

Wilson Nye ("Bill Nye"), (1850-1896); George Washington Peck (1840); Opie Read (1852); John G. Saxe (1816-1887), whose first book appeared in 1846; H. W. Shaw

LORD BYRON.

(1818-1885), "Josh Billings"; Benjamin P. Shillaber (1814-1890), the famous "Mrs. Partington," whose first volume was published in 1853; and Seba Smith (1792-1868), "Jack Downing," whose humor electrified the country during Andrew Jackson's administration, and whose "Letters" appeared in 1833. There are many other minor writers, notably in the periodical press, who have given to the world an amount of bright, humorous literature that no other nation during the century has equaled either in quantity or quality.

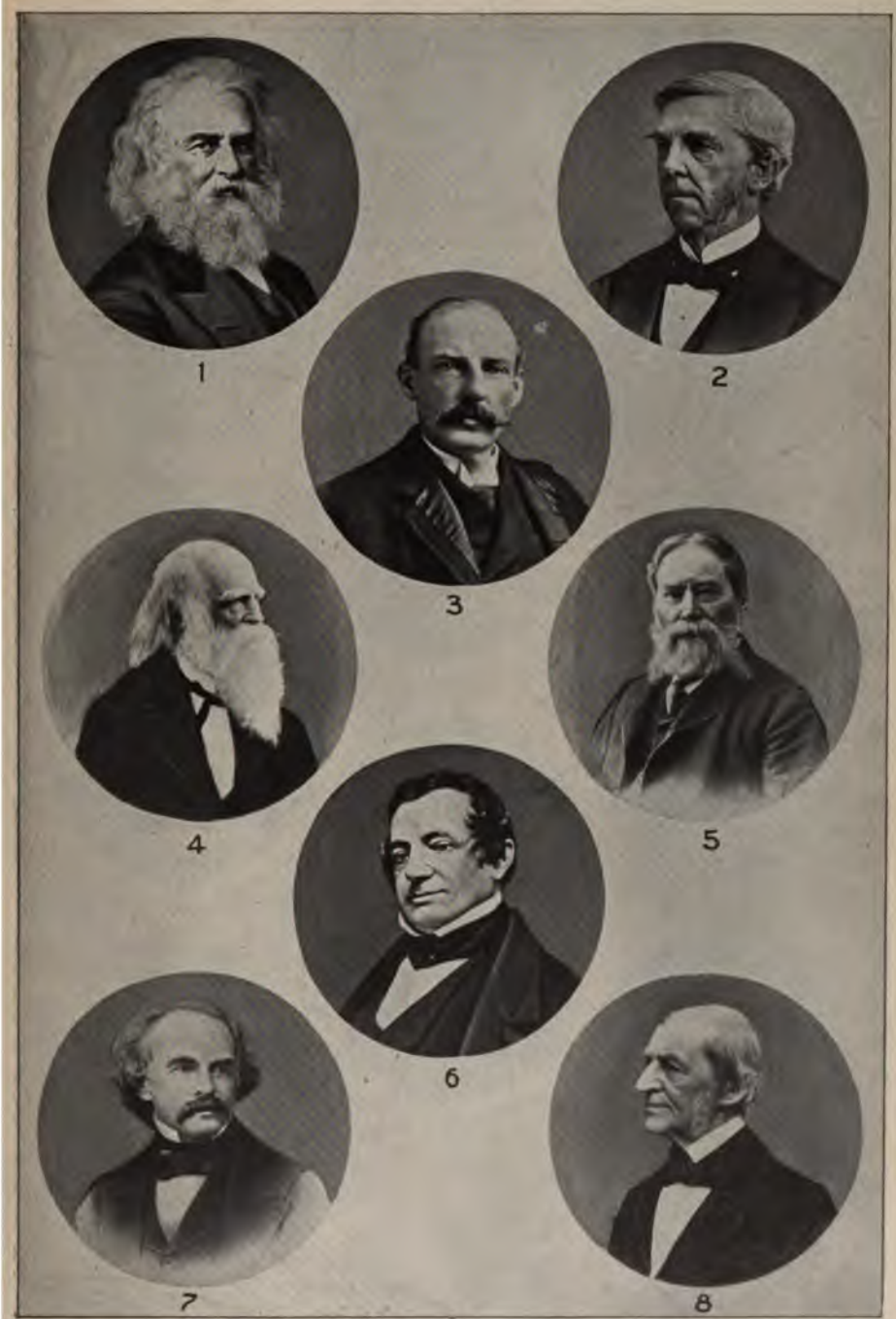
With the exception of Charles Brockden Brown's (1771-1810) novels, three of which appeared in the first year of this century, it may be said that no works of fiction of any special interest now, antedate the current hundred years. The first to electrify the nation, and delight the English-speaking world, was James Fenimore Cooper (1789-1851). His works were of thrilling interest to American readers, and appeared rapidly, almost one a year, from 1821 to 1850, and are yet among the most popular novels. He is the American Scott. J. K. Paulding (1779-1860); John P. Kennedy (1795-1870), produced "Horseshoe Robinson" in 1835. William Gilmore Simms (1806-1870) was a more voluminous writer than Cooper, and was more popular a generation ago, especially in the South, than at present. He wrote, from 1827 to 1860, some forty volumes. Nathaniel Hawthorne (1804-1864) published his first work in 1828, "Fanshawe," and followed it until 1883 with works of marvelous power, such as "The Scarlet Letter," 1850; "The House of Seven Gables," 1851; "The Marble Faun," 1860, etc. Hawthorne occupies a room by himself in the

ROBERT BROWNING.

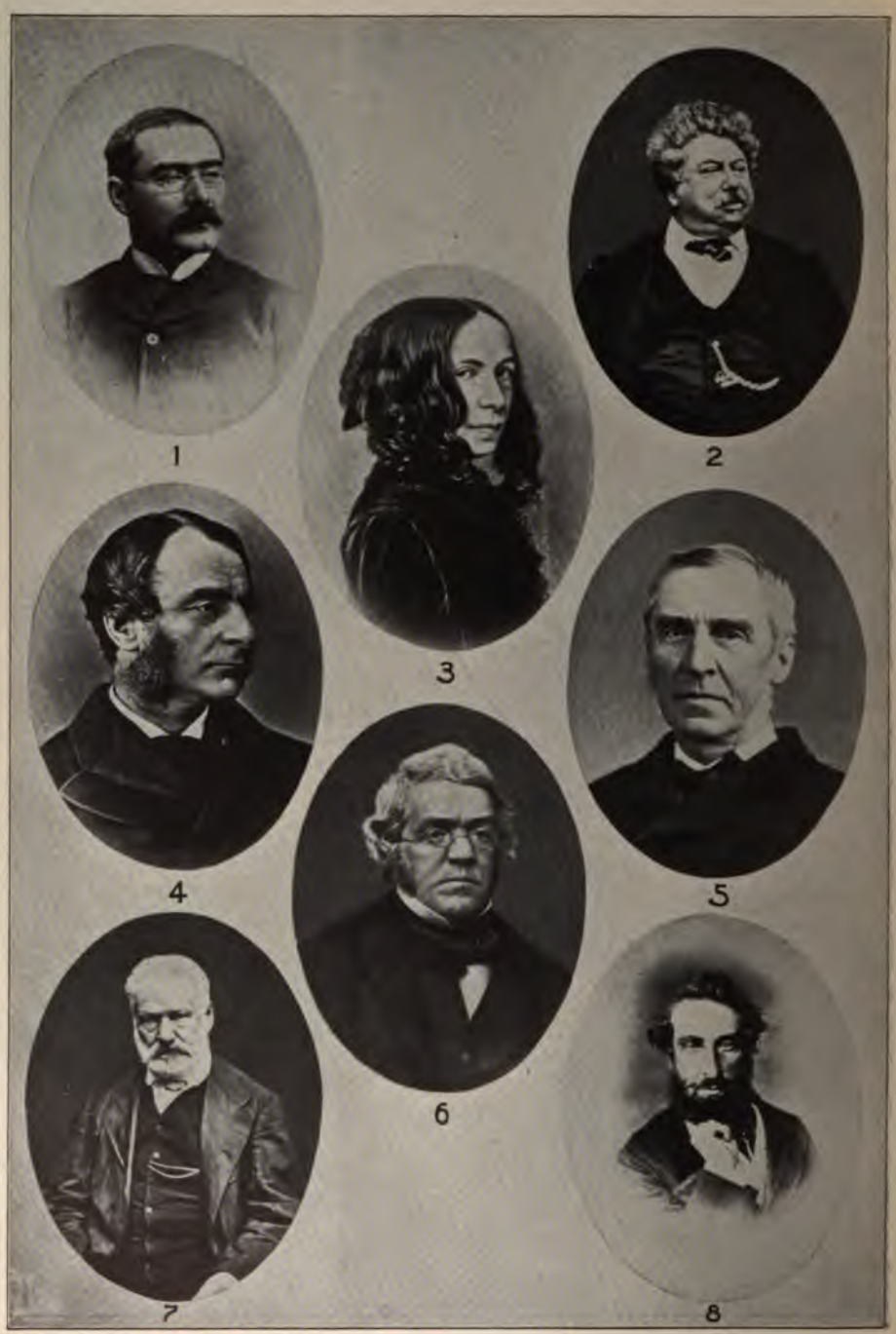
temple of Fame. Charles Fenno Hoffman (1806-1884) wrote several novels of interest. Daniel P. Thompson (1793-1868) was author of the yet famous "Green Mountain Boys,"

written in 1840. Thomas Bailey Aldrich (1836). His "Bad Boy," "Marjorie Daw," "Prudence Palfrey," "The Stillwater Tragedy," and many other books, prove him as good a novelist as poet. Elizabeth Stuart Phelps (1844), the author of "The Gates Ajar," "Hedged In," and other remarkable novels; Francis R. Stockton, author of the "Rudder Grange," "The Lady or the Tiger," and a long catalogue of most original works; William Dean Howells (1837), the most voluminous and popular novelist of the end of the century; E. P. Roe (1838-1888), the author whose stories have had a wider circulation than those of any other American author; Edward Eggleston (1837); Lewis Wallace (1827), author of the immortal "Ben Hur" (1880), and other great books; Henry James, Jr. (1843), perhaps the most successful of American novelists, whose more than thirty novels are widely read; Constance Fenimore Woolson (1848-1894); A. S. Hardy (1847); Sarah Orne Jewett (1849), a writer of great power; Rose Terry Cooke (1827-1892), Mary Hartwell Catherwood (1847); Frances Eliza Hodgson Burnett (1849, American by adoption), whose "Lass o' Lowrie's," "Fair Barbarian," "Little Lord Fauntleroy," and other fascinating productions, rank her high on the roll of novelists; George Washington Cable (1844), the novelist of the South; Hjalmar Hjorth Boyesen (1848, Norwegian born); Julian Hawthorne (1846); Silas Weir Mitchell (1829); Francis Marion Crawford (1853), greatest of living American novelists; H. C. Bunner (1855); Mary N. Murfree, "Charles Egbert Craddock" (1850), whose "Tennessee Mountains," "Great Smoky Mountains," and other novels are among the best in literature; Amelia H. Barr (1831); Margaret Deland Campbell (1857), the author of "John Ward, Preacher"; Mary Hallock Foote (1847), one of the few great story writers living; Ruth M. Stuart (1856); Alice French, "Octave Thanet" (1850); Edward Bellamy (1850), whose "Looking Backward" has reckoned its readers by hundreds of thousands; Gilbert Parker (1861); Thomas Nelson Page (1853), the charming novelist of Southern life; Rudyard Kipling, who, though born in British territory, has made America his home; Mary E. Wilkins (1855), the remarkable delineator of New England life; F. R. Stockton (1834); Mrs. E. D. E. N. Southworth (1818); Mrs. H. P. Spofford (1835); Winston Churchill, author of "Richard Carvel," and E. N. Westcott, author of "David Harum."

Besides these may be named some of those who tilled the same fields with smaller results, such as Robert M. Bird (1805-1854), Lydia Maria Child (1802-1880), Albion W. Tourjee (1838), Sylvanus Cobb, Jr. (1823), Charles King (1844), A. C. Gunter, John Habberton (1842), Rebecca Harding Davis (1840), Mrs. Burton Harrison, Herman Melville (1819-1891), E. S. Phelps Ward (1844), Theodore Winthrop (1828-1861), and many others. Besides the novelists less great, surely the Nineteenth Century may with pride boast of the following unequaled



1. Henry W. Longfellow. 2. Oliver W. Holmes. 3. F. Marion Crawford.
4. William C. Bryant. 5. James R. Lowell.
6. Washington Irving. 7. Nathaniel Hawthorne. 8. Ralph W. Emerson.



1. Rudyard Kipling. 2. Alexandre Dumas. 3. Elizabeth B. Browning.
4. Charles Kingsley. 5. James A. Froude.
6. William M. Thackeray. 7. Victor Hugo. 8. Edward G. E. Lytton Bulwer.

names: Cooper, Hawthorne, Stowe, Helen Hunt Jackson, Holmes, Harte, Winthrop, Howells, Wallace, James, Burnett, Crawford, and Deland.

Undoubtedly the most original and greatest of American novelists, Nathaniel Hawthorne (1804-1861), will long occupy the eminence he attained during his lifetime. Graduating from Bowdoin in 1825, he returned to Salem, Massachusetts, his native place, and began writing anonymously. For several years his genius was unrecognized, but in 1837 "Twice Told Tales" appeared, and attracted some, but not very enthusiastic notice. After serving as weigher and gauger in the Boston Custom House, he joined the Brook Farm association of Transcendentalists, in which, he afterward said, "the real Me was never an associate." Married and removed to Concord, the "Mosses of an Old Manse" was suggested, and after three years in Concord he was appointed surveyor of the port of Salem. Here, in an obscure corner of the custom house, he found the document that suggested "The Scarlet Letter." In 1850 he removed to Lenox, and wrote the famous "House of Seven Gables," and others of his remarkable works, and then, receiving from President Franklin Pierce (1804-1869) the appointment of Consul to London, he spent some years in Europe, during which he produced "The Marble Faun." The three works above named are the foundations on which his great fame will always securely rest, though "Mosses," "Blithedale," and other books are worthy of his great genius. Returning to his native country, his health was impaired, and continued to decline. In the hope of improvement, Hawthorne set out with his constant friend, President Pierce, on a journey to the White Mountains, in the month of May. On the 18th the two college boys, now two gray-haired men, reached the town of Plymouth. Hawthorne retired early to rest. At four in the morning Pierce arose, went to his friend's bedside, laid his hand upon him gently, and found that life was extinct. The body was brought to Concord. Longfellow, Emerson, Holmes, Lowell, and many other literary friends stood around the bier when the coffin was lowered into its final resting-place in Sleepy Hollow cemetery, Concord. Upon the coffin was laid Hawthorne's unfinished romance, of which Longfellow has so beautifully said:

"Ah, who shall lift that wand of magic power,
And the lost clew regain?
The unfinished window in Aladdin's tower
Unfinished must remain."

The most popular of modern poets, wherever the English language is spoken, if not the greatest of American singers, as his admirers will claim, is Henry W. Longfellow (1807-1882). Not yet eighteen when he wrote "An April Day" and other of his earlier poems, he was appointed professor of modern languages in his *alma mater*, in 1831, and began the performance of his duties at the college. In 1835 he received the appointment he so long filled in Harvard. He occupied the house so well known, famous as the headquarters

of Washington during the Revolution, and here, for almost fifty years, he wrote the fascinating productions that have delighted two continents. "Voices of the Night" and "Ballads and Other Poems" appeared in 1841; "Evangeline," in 1847; "The Song of Hiawatha," in 1855; "Courtship of Miles Standish," 1858; "Tales of a Wayside Inn," 1863; "Flower de Luce," 1867; "New England Tragedies," 1868; "Three Books of Song," 1872; "Aftermath," 1874; "The Mask of Pandora," 1875; "Poems of Places," 1876-1879; "Keramos," 1878; "Ultima Thule," 1880, etc. There are few poems that so charm readers as do "The Psalm of Life," "Paul Revere's Ride," "The Wreck of the Hesperus," "Hiawatha;" in fact, most of his poems attract the eye, allure the mind, win the heart and remain a delightful memory with all readers who love the simple in language, the melodious in expression, the elevated and pure in sentiment. It is doubtful if any one of Longfellow's contemporaries, or any modern author is so widely read or so highly esteemed as he. His poems have been translated into every cultivated tongue; and that universality which he instinctively felt to be the only measure of true greatness has welcomed him to the great brotherhood of cultivated nations as a benefactor of mankind. Cardinal Wiseman, in England, long ago voiced the feelings of millions of readers of Longfellow: "Our hemisphere cannot claim the honor of having brought him forth, but he still belongs to us, for his works have become as household words wherever the English language is spoken. And whether we are charmed by his imagery, or soothed by his melodious versification, or elevated by the moral teachings of his pure muse, or follow with sympathetic hearts the wanderings of Evangeline, I am sure that all who hear my voice will join with me in the tribute I desire to pay to the genius of Longfellow."

Harriet Beecher Stowe (1812-1899), the immortal author of "Uncle Tom's Cabin," which appeared in 1852, had already published the "Mayflower," and subsequently wrote "The Minister's Wooing" (1859), and several other books. But "Uncle Tom" reached the largest circulation of any work of fiction ever printed, and produced a larger influence in changing public sentiment than was ever accomplished in the same time. The circumstances under which "Uncle Tom" was written are these: "Upon his return to New England, Professor Stowe, the husband of Mrs. Harriet Beecher Stowe, had accepted the appointment of Divinity Professor at Bowdoin, and with his gifted wife had taken up his residence at Brunswick, Maine. It was there, while occupied with the cares of a family, that Mrs. Stowe received from Doctor Bailey, of the 'National Era,' Washington, D. C., a request for the great story, which first appeared in the weekly issues of that paper. Having once been a victim of mob violence in Cincinnati himself, no man could better appreciate the truth of 'Uncle Tom' than Doctor Bailey.

ew and esteemed the Beech-
He had read with approval
towe's first volume of tales,
ayflower,' which she brought
1849. Upon this request,
was accompanied with a check

ALFRED TENNYSON.

00.00, Mrs. Stowe began to
luring such intervals as could
ched from household duties.
nbition had been aroused in
e direction. She wrote on
creasing force and intensity.
told how absorbed and fasci-
she became with her theme,
ith what fidelity she repro-
he scenes that had filled her
ly soul with horror and indig-
But as yet 'Uncle Tom'
de little impression upon the
The 'National Era' was a
n newspaper of limited influ-
so limited, indeed, that com-
ely few persons are now
hat Mrs. Stowe's great novel
w the light in its columns."
brother, Henry Ward Beecher
887) was a voluminous author,
novel "Norwood" (1868) had
success. J. H. Ingraham (1809-1866); Sylvester Judd (1813-1853), whose "Margaret" was supposed to be the long-looked-for American novel; Susan Warner, "Elizabeth Wetherell" (1819-1885), the author of "The Wide, Wide World" (1850); John T. Trowbridge (1827); Dr. J. G. Holland (1819-1881); "Timothy Titcomb," novelist, essayist, poet; R. T. S. Lowell, the great poet's brother (1816-1891); Helen Hunt Jackson (1831-1885), the author of "Ramona," by many thought to be the best American novel, written in 1884; Dr. O. W. Holmes (1809-1894), poet, novelist, wit, man of science, perhaps the most versatile genius in American literature, whose works charmed the world for almost sixty years, and bid fair to be as popular generations hence as now; Francis Bret Harte (1839), the most unique of our

CHARLOTTE BRONTE.

novelists; Mary Mapes Dodge (1838), and hundreds more who a century ago would have been celebrated.

Thomas Bailey Aldrich.—The poetry by Aldrich includes "Babie

ls," "The Course of True Love Never Did Run mooth," "Pampinea, and Other oems"; "Flower and Thorn," and Sonnets." Among his prose works are "Story of a Bad Boy," "Marjory Daw and Other People," "Prudence Palfrey," "The Queen of Sheba," "The Stillwater Tragedy," "From Ponkapog to Pesth," "Mercedes," and very many translations, magazine articles and stories.

Bret Harte, at the age of thirty, immortalized himself by "The Luck of Roaring Camp." Soon after ap- d "The Outcast of Poker Flat," 70, "Plain Language fror James; or, The Heathen Cnu Since then he has be regarded as one of the brightest American authors.

Richard Henry Stoddard has produced "Adventures in Fairyland," "Town and Country," "The Story of Little Red Riding Hood," "The Children in the Wood," "Putnam the Brave," "Memoir of Edgar Allan Poe," the "Bric-a-Brac," "Sans Souci Series" of compilations, and a number of volumes relating to English literature.

The author of "The Gates Ajar," Elizabeth Stuart Phelps Ward, was born in Boston, Massachusetts. Her published works include "Ellen's Idol," "Up Hill," "The Tiny Series," "The Gypsy Series," "Mercy Gliddon's Work," "I Don't Know How," "Gates Ajar," "Men, Women and Ghosts," "The Silent Partner," "Hedged In," "The Story of Avis," "My Cousin and I," "Old Maid's Paradise," "Sealed Orders," "Jack, the Fisherman," "The Master of the Magicians," and many others, besides numerous sketches, stories and poems for magazines. Her most popular book is "The Gates Ajar," which reached its twentieth edition within a year after its publication.

Emily Dorothy Eliza Nevitte Southworth was born in Washington, District of Columbia, December 26, 1819. Beginning as a teacher, she soon began her life work of story writing, and has produced about sixty novels—sometimes three in a single year. Her first novel, "Retribution," appeared in the "National Era."

General Lew. Wallace, after receiving a thorough education, studied law, and during the Mexican war en- d the army as first lieutenant. the beginning of the Civil War, became colonel of volunteers. Subsequently he was commissioned brigadier-general, and then major-general of volunteers. He was at the capture of Fort Donelson and Shiloh, and in 1863 prevented the capture of Cincinnati by the Confederates. After the war Gen. Wallace devoted himself to the practice of law and literature at his home in Crawfordsville, Ind. His publications are very popular and have had an enormous sale. They include "The Fair God," 1873; "Ben Hur, a Tale of the Christ," 1880; "The Boyhood of Christ," and "The Prince of India," 1893.

Francis Marion Crawford (1854) is the son of Thomas Crawford, the sculptor. His first novel, "Mr. Isaacs," made him famous in the literary world, and his succeeding ones, which have followed one an-

in rapid succession, have been ly sought. He has been led a prize of one thousand s by the French Academy as cknowledgment of the merit s novels, and especially two of , "Zoroaster," and "Marzio's fix," which were written in ch as well as in English. His , "Katharine Lauderdale," is listic American story.

lliam Dean Howells is the l author of "The Rise of Silas am," "The Lady of the Aroos- " "A Woman's Reason," and other popular stories of the tic school. During his resi- in Venice he mastered the n language and studied the lit- re of the country. Mr. How- s recognized as the leader of ealistic school of literature. In he became editor of the "At- Monthly," a position which eld until 1880, when he relin- ed it to devote himself exclu- to writing. In addition to his ls, he has written many poems, aphies, criticisms and sketches vel in foreign countries.

at other American author s so charmingly of bird life, fields, rural fancies and obser- ns, and the impressions of na- as John Burroughs (1837)? The bracing air of the country hes through almost everything comes from his gifted pen. His s are "Wake Robin," "Winter hine," "Birds and Poets," usts and Wild Honey," "Pepac- "Fresh Fields," "Signs and ons," "Indoor Studies," and es on Walt Whitman as Poet and Person." As an author and naturalist, he is a worthy successor of Thoreau.

Early in the century came William Cullen Bryant (1794-1878), who produced the immortal "Thanatopsis," in 1817, and followed it for sixty years with such poems as delighted the world. And the century has been immortalized by such names as Lydia Huntley Sigourney (1791-1865), John Pierpont (1785-1866), John Neal (1793-1876), John Howard Payne (1791-1852), author of "Sweet Home"; Samuel Woodworth (1785-1842), who wrote the "Old Oaken Bucket"; Joseph Rodman Drake (1795-1820), whose "Ode to the American Flag" and "Culprit Fay" prophesied great things, had he not died at the early age of twenty-five; Alex. Wilson (1766-1813); Fitz Greene Halleck (1790-1867), author of "At Midnight in His Guarded Tent"; Joseph Hopkinson (1770-1842), author of "Hail Columbia"; J. G. Percival (1795-1856); Hannah E. Gould (1789-1865); Charles Sprague (1791-1875); John G. Brainerd (1796-1828); Maria G. Brooke (1795-1845) "Maria del Occidente"; James A. Hillhouse (1789-1841); George P. Morris (1802-1864), author of "Woodman, Spare that Tree"; Edward C. Pinkney (1802-1828); George Lunt (1803-1885); Francis S. Key (1779-1843), who wrote "The Star Spangled Banner" (1815); R. H. Dana (1787-1879), R. H. Dana, Jr. (1815-1882); Edgar Allan Poe (1809-1849), whose "Raven," "Bells," "Lenore," and many other lyrics are among the finest in literature; N. P. Willis (1806-1867); Lucretia M. Davidson (1808-

1825); H. W. Longfellow (1807-1882), the most popular of American poets; John G. Whittier (1807-1892), the best loved of all the sons of song; Albert Pike (1809-1891), Ralph Waldo Emerson (1803-1882), Lydia Maria Child (1802-1880), O. W. Holmes (1809-1894), Frances S. Osgood (1811-1850), Jones Very (1803-1880), Christopher P. Cranch (1813-1892), Thomas Dunn English (1819), W. E. Channing (1818), Bliss Carman (1861), Thomas W. Parsons (1819-1892), Willis Gaylord Clarke (1810-1841), George H. Boker (1823-1890), Thomas B. Read (1822-1872), Epes Sargent (1813-1880), Alice Cary (1820-1871), Phœbe Cary (1824-1871), R. H. Stoddard (1825), Julia Ward Howe (1819), Helen H. Jackson (1831-1885), J. G. Holland (1819-1881), E. C. Stedman (1833), W. W. Story (1819-1896), Lucy Larcom (1826-1893), H. H. Brownell (1826-1872), Alfred B. Street (1811-1881), T. B. Aldrich (1836), S. F. Smith (1808-1895), author of "America," Bayard Taylor (1825-1878), Paul H. Hamilton (1830-1886), John Hay (1838), P. F. Hayne (1830-1886), T. W. Parsons (1819-1892), J. R. Lowell, Walt Whitman (1819-1892), Will Carleton (1845), John Boyle O'Reilly (1814-1890), F. J. O'Brien (1828-1862), Charles G. Halpine (1829-1868), Sidney Lanier (1842-1881), J. Whitcomb Riley (1852), Celia L. Thaxter (1836-1894). R. W. Gilder (1844), Mrs. Elizabeth Akers ("Florence Percy"), Hattie T. Griswold (1842), Elaine Goodale (1863), Eugene Field (1850-1895), Emma Lazarus (1849-1887), Rose Terry Cooke (1827-1892), W. A. Muhlenberg, author of "I Would Not Live Alway" (1796-1877), Wm. Watson (1856), Ella W. Wilcox (1859).

Easily the predecessor of the American poets of the day who have described country life, though he used little or no dialect in doing it, stands Will Carleton, the Michigan poet, author of "Over the Hills to the Poorhouse," and similar poems, which have touched the hearts of the American public. His published books include "Poems" (Chicago, 1871), "Farm Ballads" (New York, 1873), "Farm Legends" (1875), "Young Folks' Centennial," "Rhymes," "Farm Festivals," "City Ballads," and others.

Joaquin or Cincinnatus Hiner Miller was born in Indiana, November 10, 1841. He began editorial life in Oregon, and his poems about 1870. He is one of the great poets of the country, he loves so much and sings so well. In 1871 he published, in London, "Songs of the Sierras" and "Pacific Poems." In 1873 appeared "Songs of the Sun Lands," and a prose volume entitled "Life Among the Modocs," "Unwritten History." His later works are the "Ship in the Desert," 1875; "The Danites in the Sierras," "The One Fair Woman," 1876; "Baroness of New York," 1877; "Songs of Far Away Lands," 1878; "Songs of Italy," 1878; "Shadows of Shasta," 1881; "Memorie and Rime," 1884; "Forty-nine, the Gold Seeker of the Sierras," 1884.

Celia Laighton Thaxter was born in Portsmouth, New Hampshire, June 29, 1835. In her childhood she

oved to Isles of Shoals, and there wrote her exquisite poetry, ng the most original and purest merican literature.

hn Greenleaf Whittier (1807-), the Quaker poet, the reform , the poet of New England, of re, and the heart, is undoubt- more loved than any poet of century, and his muse is exer- g a more beneficent influence any other.

brilliant historical library has built by such authors as Jared rks (1789-1866), George Bancroft o-1891), "History of the United es," written from 1834 to 1874; rge Ticknor (1791-1871), William Prescott (1796-1859), "Ferdinand Isabella," 1837, etc.; Richard ireth (1807-1865), J. T. Headley 3), John L. Motley (1814-1877), tch Republic," 1856; J. S. C. ott (1805-1877), "Napoleon aparte" (1855), etc.; John G. rey (1796-1881), Francis Park- (1823-1893), Thomas H. Benton 2-1858), James G. Blaine, irty Years," (1884); James ton (1822-1891); Henry Cabot lge (1850), James Schouler 9), "History of the United tes," Nicholas and Hay's "Life Abraham Lincoln"; John Bach Master (1852).

f Dictionaries and Encyclo- lias, Noah Webster's (1758-1843), 806; Joseph E. Worcester's (1784- 5), in 1830; "The Century," in 9-91; Encyclopædia, 1829; the w Encyclopædia (1858); John- 's Encyclopædia, 1874; Conkey's cyclopædic Dictionary, 1895, etc. Var literature, W. T. Sherman's (1820-1891), "Memoirs," 1875; U. S. Grant's (1822-1885) "Personal Memoirs," 1885; P. H. Sheridan's (1831-1888) "Personal Memoirs," 1888; Jefferson Davis's (1808-1889) "Rise and Fall of the Confederate Government," 1881.

A literary episode of the century was the publication of the "Lowell Offering," a monthly magazine, established in Lowell, Massachusetts, in 1840, entirely written by girls working in the cotton mills. It was the first magazine ever published by manual workers, or by women.

Ignatius Donnelly (1831) has produced several volumes displaying great imagination, but the most imaginative of all, most readers would say, is his "Cryptogram," which attemps to prove that Lord Francis Bacon was the author of Shakespeare's works. The book shows great ability.

In natural history such books were never written until J. J. Audubon (1780-1851) and Alexander Wilson (1766-1813) wrote of ornithology, and how delightfully have the works of nature been described by Henry D. Thoreau (1817-1862), Wilson Flagg (1805-1884), John Muir (1836), John Burroughs (1837), Olive Thorne Miller, William Hamilton Gibson (1850), John Cassin (1813-1869), Elliott Coues (1842), George Wood (1799-1870), and in the works of Louis Agassiz (1807-1883), Ed. D. Cope (1840-1897), and Alexander Winchell (1824-1891).

And childhood seems to have been discovered by Literature in this century, for never before did children

have a literature, in this or any other country. From the days of Maria Edgeworth, "Peter Parley," S. G. Goodrich (1793-1860), have followed "Oliver Optic," William T. Adams (1822-1897), Rebecca Clarke, author of the "Prudy" stories and "Dottie Dimple"; Louisa M. Alcott (1832-1888), Horace E. Scudder (1838), J. T. Trowbridge (1827), J. Whitcomb Riley (1852), Jacob Abbott (1803-1879), the "Rollo Books," etc.

John Townsend Trowbridge, born in Ogden, New York, September 8, 1827, is a wonderful delineator of human nature, and is a poet of real ability. Several of his books have had great success. His contributions to "Our Young Folks" and the "Atlantic Monthly," give him a high position in the estimation of all lovers of healthful literature.

Thousands of middle-aged men of to-day hold in loving remembrance the name of "Oliver Optic", a name that was associated with their boyhood's pleasures quite as intimately as was that of Santa Claus himself. William Taylor Adams was born in Medway, Massachusetts, July 30, 1822. He was for twenty years a teacher in the public schools of Boston, fourteen years a member of the school committee of Dorchester, and one year a member of the legislature. His literary career began in 1850, and he has produced over a thousand stories in newspapers, exclusive of his books. In early life he edited the "Student and Schoolmate," and in 1881, "Our Little Ones," but he is best known as an editor through "Oliver Optic's Magazine for Boys and Girls." He has published about a hundred volumes in all. No writer ever exerted a greater or more wholesome influence on the minds and hearts of the "young folk."

Among political writers are James Kent (1763-1847), Joseph Story (1779-1845), Robert C. Winthrop (1809), Francis Lieber (1800-1872), Horace Greeley (1811-1872), Charles Sumner (1811-1874), Francis A. Walker (1840), Elisha Mulford (1833-1885), Henry George (1839-1898), Henry C. Carey (1793-1879), Parke Godwin (1816), A. L. Perry (1830).

Writers in many departments have done much to exalt American literature. Abigail Adams (1744-1818), Hannah Adams (1755-1832), Felix Adler (1851), Horatio Alger (1834-1899), W. R. Alger (1822), E. Grant Allen (1848-1899), Mary C. Ames (Hudson) (1839-1874), T. S. Arthur (1809-1885), Henry Barnard (1811), E. Bellamy (1850), Gould Brown (1791-1851), O. A. Brownson (1803-1876), Phillips Brooks (1835-1893), Lydia M. Child (1802-1880), C. C. Coffin (1823), G. W. Curtis (1824-1892), John E. Cook (1836), Francis J. Child (1825), R. H. Dana, Jr. (1815-1882), Mary A. Dodge, "Gail Hamilton" (1830), H. H. Furness (1833), Margaret Fuller (Ossoli 1810-1850), Hamlin Garland (1860), Asa Gray, the great botanist; R. W. Gilder (1844), E. L. Godkin (1831), A. C. Gunter (1847), Alexander Hamilton (1757-1804), J. C. Harris (1848), Lafcadio Hearn (1850), Greek born; John Hay (1838), Sidney Lanier (1842-1881), G. P. Marsh (1801-1882), Brander Matthews (1852), Herman Melville (1819-1891), Lindley Murray (1745-1826), Sara J. Lippin-

("Grace Greenwood") (1823), Mitchell (1822), C. E. Norton), James Parton (1822-1891), nas Paine (1737-1809), H. E. ord (1835), Caroline M. Sedg- (1789-1867), B. F. Taylor (1819- , Maurice Thompson (1844), E. hipple (1819-1866), Andrew D. e (1832), R. G. White (1821- , A. D. T. Whitney (1824), W. er (1836), Theo. D. Woolsey -1889), E. L. Youmans (1821- .

nong the principal theological religious authors are Samuel tins (1721-1803), Hosea Ballou -1852), Hosea Ballou, 2d (1796- , Andrews Norton (1786-1853), thy Dwight (1752-1817), Lyman her (1775-1863), William Ellery ning (1780-1842), Theodore er (1810-1860), James Freeman te (1810-1888), Mark Hopkins -1887), O. A. Brownson (1803- , Philip Schaff (1819-1893), W. Alger (1822), A. P. Peabody -1893), George Bush (1796- , George P. Fisher (1827), an Abbott (1835), Phillips ks (1835-1893), O. B. Frothing- (1822-1895), T. T. Munger), Washington Gladden.

ithout further classification the e works of the following authors among the most brilliant pro- ions in the English langugae: hington Irving (1783-1859), se works were published from to 1866; J. K. Paulding (1778-), Washington Allston (1779-), Henry W. Longfellow (1807-), whose prose would have ered him famous; William e (1797-1852), Horace Mann (1796-1859), Ralph Waldo Emerson (1803-1882), the greatest name perhaps in American literature, whose productions stretch across sixty-three years, from 1830 to 1893; William Wirt (1772-1834), Edward Everett (1794-1865), S. A. Allibone (1816-1889), Amos Bronson Alcott (1799-1888), H. C. Bunner (1855-1896), George P. Marsh (1801-1882), Horace Bushnell (1802-1876), George H. Calvert (1803-1889), Matthew F. Maury (1806-1873), Frances A. Kemble (Butler) (1809-1893), Sarah P. W. Parton (1811-1872), "Fanny Fern;" Margaret Fuller (Ossoli) (1810-1850), Charles F. Hoffman (1806-1884), John S. Dwight (1813-1893), John W. Draper (1811-1882), Francis Bowen (1811-1890), Donald G. Mitchell, "Ik Marvel" (1822), Charles T. Brooks (1813-1883), Henry T. Tuckerman (113-171), Edward Everett Hale (1822), one of the brightest names in American literature; H. N. Hudson (1814-1886), Edwin P. Whipple (1819-1886), George W. Curtis (1824-1892), Charles G. Leland (1824), Frederick S. Cozzens (1818-1869), R. H. Dana, Jr. (1815-1882), T. S. Arthur (1809-1885), Herman Melville (1819-1891), M. D. Conway (1832), Thomas Star King (1824-1863), Mary M. Dodge (1840), Oliver Wendell Holmes (1809-1894), whose miscellaneous writings rank as high as his poetry and novels; James T. Fields (1817-1881), Charles Nordhoff (1830), T. W. Higginson (1823), William T. Harris (1835), T. W. Parsons (1819-1892), Charles Francis Adams (1807-1886), C. F. Adams, Jr. (1835), Wendell Phillips (1811-1884), Henry Adams (1838),

George P. Lathrop (1851), William D. Howells (1837), whose miscellaneous works, almost as much as his novels, place him among the masters of English, Richard Grant

GEORGE BANCROFT.

White (1821), Charles Dudley Warner (1829), one of the principal authors of the century; Moses Coit Tyler (1835), E. L. Youmans (1821-1887) William Winter (1836), Fitz Hugh Ludlow (1836-1870), John Fiske (1842), Maurice Thompson (1844), Edgar Fawcett (1847), Theodore Roosevelt (1858), Bronson Howard (1842), Hamlin Garland (1860).

Charles Dudley Warner is a native of Plainfield, Massachusetts. He had a considerable editorial experience in Hartford, Connecticut, and has been a voluminous contributor to the "Knickerbocker," "Putnam's Magazine," and "Harper's Magazine." His "Being a Boy," "My Summer in a Garden," "Backlog Studies," "Our Italy," and other works rank him among the bright lights in American literature.

Edward Everett Hale, D. D., the associate of Emerson, Parkman, Lowell, and Longfellow, was born in Boston, Massachusetts, April 3, 1822. After graduating at Harvard, in 1839, he studied theology and became a Unitarian minister. The first book that gave him international fame was "The Man Without a Country," which appeared in 1861. Prior to that he had produced "The Rosary," in 1848, and "America," in 1856. Among his subsequent works may be mentioned "His Level Best," and other stories, 1872; "Ups and Downs," 1873; "Working Men's Homes," "In His Name," 1874; "Philip Nolan's Friends," 1876; "Boys' Heroes," 1885; "What is the American People," 1885. He edited a series of stories of the war, sea, adventure, etc., from 1880 to 1885.

John Fiske was born in Hartford, Connecticut, March 30, 1842. He

EDGAR ALLAN POE.

was graduated at Harvard, and at once became a brilliant writer on philosophical theories, particularly on evolution, Darwinism, etc. He ranks high among the great thinkers,

such as Darwin, Spencer, Huxley, Tyndall and other philosophers.

Thomas Nelson Page, born in Oakland, Virginia, April 23, 1853, is author of delicious stories of the civil war in the South, among which "Marse Chan" and "Meh Lady" delighted the nation.

Bronson Howard, born in Detroit, October 7, 1842, is a most successful American playwright. After considerable journalistic experience, he began to dramatize for the theater, and his "Saratoga," "The Banker's Daughter," "Young Mrs. Winthrop," and "Shenandoah," have had great success. His plots and dramatic situations are skillfully arranged, and his plays are very successful.

George Washington Cable is a native of New Orleans. He served in the Confederate army from 1863 to 1865, being severely wounded, and after the war returned to New Orleans, penniless. He had a hard struggle for existence for a time, but finally attracted attention through a series of clever articles published in the New Orleans "Picayune," and in 1878 his sketches of Creole life began to appear in "Scribner's Magazine." Among his most popular works are "Old Creole Days," "The Grandissimes," "Bonaventure," "The Creoles of Louisiana," "Doctor Sevier," "The Silent Youth," "John March, Southerner," etc.

On the Eastern continent the multiplication of authors has been equally great. While there has been no Dante Alighieri (1265-1321) or Torquato Tasso (1544-1595) in Italy; nor Miguel Cervantes (1547-1616) in Spain, France has produced its greatest authors during the century.

The mere names of some of the principal authors in continental Europe will be a revelation to most readers; such as E. F. V. About (1828-1885), Juliette Adam (1836), Vittorio Alfieri (1749-1803), E. M. Arnott (1769-1860), M. M. Altaroche (1811-1884), H. F. Amiel (1821-1881), F. J. D. Arago (1786-1853), Gustave Aimard (1818-1883), J. L. Almquist (1793-1866), B. Auerbach (1812-1882), P. A. Alarcon (1833-1891), E. de Amicis (1846), H. C. Anderson (1805-1875), J. H. Merle d'Aubigné (1794-1872), J. I. Baggesen (1764-1826), H. de Balzac (1799-1850), P. Charles Baudelaire (1821-1867), P. J. Beranger (1780-1857), Paul Blouet (1848) ("Max O'Reill), B. Björnson (1832), Louis Blanc (1811-1882), C. G. G. Botta (1768-1837), K. W. Bottiger (1807-1878), H. H. Boyesen (1848-1895), Frederika Bremer (1802-1865), C. Brentano (1777-1842), Paul Bourget (1852), G. M. C. Brandes (1852), Fermin Caballero (1796-1877), Victor Cousin (1792-1867), Alexandre Chartrain (1826-1890), F. R. A. Chateaubriand (1768-1848), G. C. L. F. D. Cuvier (1769-1832), Auguste Comte (1798-1857), J. Campanini (1752-1825), H. L. Carnot (1801-1888), Alphonse Daudet (1840-1897), "The French Dickens"; Rouget De-Lisle (1760-1836), author of the "Marsellaise"; D. R. Derzhavin (1743-1816), A. L. A. Dudevant (1804-1876) ("George Sand"), J. J. I. VonDöllinger (1799-1890), Alex.

Dumas, *pere* (1802-1870), Alex. Dumas, *fils* (1824-1895), G. M. Ebers (1837), Octave Feuillet (1821-1890), L. H. K. La Motte Fouque (1777-1843), F. Freiligrath (1810-1876), Camille Flammarion (1842), E. Erckman (1822), G. Freytag (1816), J. B. J. Fourier (1768-1830), Friedrich Fröbel (1782-1852), J. G. Fichte (1762-1814), T. Gaultier (1811-1872), F. P. G. Guizot (1787-1874), George Maurice de Guerin (1810-1839), Eugenie de Guerin (1805-1848), F. E. von Geibel (1815-1844), J. W. Goethe (1749-1832), E. D. Girardin (1806-1881), H. Grimm (1828), Wilhelm C. (1786-1859) and Jacob Grimm (1785-1863), F. Guizot (1787-1874), Adolph Harnack, E. H. Hæckel (1834-1894), J. G. Herder (1744-1803), G. W. F. Hegel (1770-1831), Heinrich Heine (1799-1856), Victor M. Hugo (1802-1885), Alex. von Humboldt (1769-1859), H. F. Helmholtz (1821-1894), J. H. Heyse (1830), E. T. W. Hoffman (1776-1822), H. Ibsen (1828), Immanuel Kant (1724-1804), J. B. Alphonse Karr (1808), F. G. Klopstock (1724-1823), A. F. F. von Kotzebue (1761-1819), E. L. R. Laboulye (1811-1883), J. B. P. A. Lamarck (1744-1829), H. F. R. Lamennais (1782-1854), K. T. Körner (1791-1813), F. A. Krummacher (1768-1845), R. H. Lotze (1817-1881), A. M. Lamartine (1790-1869), Guy de Maupassant (1850-1893), Giuseppe Massini (1808-1872), Prosper Mérimée (1803-1870), C. M. T. Mommsen (1817), Maarten Maartens (1858), Jules Michelet (1798-1874), Max Müller (1823), H. Moreau (1810-1838), L. C. A. de Musset (1810-1857), B. G. Nieburn (1766-1831), J. A. W. Neander (1789-1850), A. G. Oehlenschlager (1779-1850), P. J. Proudhon (1809-1866), J. F. A. Prudhonne (1839), Silvio Pellico (1789-1854), J. E. Rénan (1823-1892), J. P. F. Richter ("Jean Paul, the Only") (1763-1825), Leopold Ranke (1795-1856), F. Reuter (1810-1874), F. Rückert (1788-1866), George Sand (1804-1876), J. B. Saint Hilaire (1805), J. X. B. Saintine (1798-1865), B. S. Sainte Pierre (1737-1814), B. C. A. Sainte Beuve (1804-1869), J. C. F. Schiller (1759-1805), F. W. J. Von Schelling (1775-1854), Arthur Schopenhauer (1788-1860), F. E. D. Schleiermacher (1768-1834), A. E. Scribe (1791-1861), Henry Sienkiewicz (1846), Madame de Stael-Holstein (1766-1817), J. C. L. S. de Sismondi (1773-1842) V. Sardou (1831), H. D. F. Strauss (1808-1874), M. T. Eugene Sue (1804-1857), A. W. von Schlegel (1767-1845), H. A. Taine (1828-1893), Theodor Storm (1817-1888), S. Souvestre (1806-1854), K. W. F. Schlegel (1772-1829), E. Tegner (1782-1846), A. C. H. C. de Tocqueville (1805-1859), J. L. Thiers (1773-1853), Alexis Tolstoi 1817-1875), L. N. Tolstoi (1828), J. Turgeneff (1818-1883), L. A. Thiers (1797-1877), J. L. Uhland (1787-1862), C. M. Wieland (1733-1813), R. Wagner (1813-1883), Emile Zola (1840), J. H. D. Zschokke (1771-1848).

Of these Alfieri, Balzac, Chateaubriand, Daudet, George Sand, Dumas, Goethe, Heine, Hugo, Humboldt, Kant, Michelet, Richter, Schiller, Sue, Sienkiewicz, and Tolstoi are among the immortals. Next to

Shakespeare, the all-sided, ranks Goethe, the myriad-sided genius.

Henry Sienkiewicz, the foremost literary man in Poland, is author of "Quo Vadis," "Sword and Fire," etc.. and bids fair to enrich the literature of his country beyond all precedent.

Paul Bourget, novelist, critic, Academician, one of the forty immortals, has written twenty volumes, and is one of France's most brilliant writers.

Balzac, author of "Cousin Pons," "Pere Goriot," "Illusions Perdues," is one of the greatest novelists of France—the equal of Dickens or Thackeray.

Emile Zola is one of the great writers of France, and of the century. His earliest work of fiction came out in 1863—"Contes a Ninon." Toward 1870 he began the publication of his famous series of books, in which he works out the pathogeny of crime as exemplified in the Rougon-Macquart clan, a study in the causes of certain social conditions that, however unpleasant to polite ears, is regarded as a valuable appendix to criminology. In 1888 M. Zola became a Knight of the Legion of Honor.

Count Lyof Nickolaievitch Tolstoi, the most prominent of the Russian novelists, is a social reformer. The author of "Anna Karenina" is now (1899) nearly seventy. "Anna Karenina" is Tolstoi's masterpiece. Of Anna herself, George Meredith says she is the most perfectly depicted female character in all fiction. Tolstoi believes in the literalness of the words of Jesus. He holds that the only rule of life is the precise living up to the maxims of the sermon on the mount.

The remuneration received by literary men and women during this century far surpasses their revenues in any former epoch. The London "Pall Mall Gazette" gives a list that fairly represents the incomes of the profession of literature in England and France. Tennyson received $30,000 for "The Holy Grail." During the last years of his life Macmillan & Co. paid him $50,000 or $60,000 a year. For "The Revenge" alone, the "Nineteenth Century" gave him $1,600. Dickens left $500,000; Lord Lytton, $400,000; Mrs. Henry Wood, $180,000; Mrs. Dinah Craik, $85,000. Victor Hugo left property in England alone valued at $457,000. Mrs. Humphry Ward (Mary Augusta Arnold), who has been writing for only ten years has earned $300,000. She received $80,000 for "Marcella" alone. George du Maurier received $50,000 for "The Martian." On two books—"The Bonny Brier Bush" and "Auld Lang Syne"—Ian Mac Laren's profits in Great Britain amounted to $35,000. Rudyard Kipling's profits have been enormous. Their extent may be judged from the fact that the editor of the "Pall Mall Gazette" acknowledges that he paid Kipling $750 apiece for the "Barrack Room Ballads." Eleven thousand dollars was paid for "The Seven Seas." For short stories, Kipling receives two shillings a word. Conan Doyle earned $35,000 by writing "Rodney Stone." Rider Haggard gets $100

for a column of 1,500 words. In one year Stevenson cleared $35,000. The unfinished "Weir of Hermiston" was purchased for $15,000. Zola received $220,000 for his first fourteen books. Edna Lyall's income from her books is $10,000 a year. Miss Braddon charges $6,500 for a "fairly long story." But probably the highest price recently paid for a novel was $200,000 for Alphonse Daudet's "Sappho." Nor are the essayists forgotten in this distribution of gold. J. Addington Symonds left a fortune of $375,000; Doctor Morrell, the grammarian, $200,000. The publishers for Mr. Ruskin paid him $20,000 a year. "Mr. Gladstone used to earn $15,000 a year by his pen." In short, the "literary calling" is shown to be one of the most remunerative in the world.

The Elizabethan Age was made glorious by the literature produced in a few great names, but the Victorian Age far surpasses it. The Nineteenth Century eclipses all the preceding eighteen hundred years in the number, and, with a few exceptions, the splendor of its poets, novelists, historians, essayists, and authors in every department of literature.

Journalism.—Journalism is a profession that may be said to have come into being in the Nineteenth Century. The newspaper press previous to that date was but a feeble institution, and few, if any, names are conspicuous in its annals until within a few years. The daily paper was unknown, and the periodical press in any form was not even a prophecy of what it is at present. The first name of note seems to have been John Walter (1739-1812), founder of the London "Times" (January 1, 1788). (See "Printing.") The following have distinguished themselves in this great profession: L. F. Bertin (1766-1841), John Ballantyne (1772-1833), H. Niles (1777-1839), T. Ritchie (1778-1854), W. W. Seaton (1785-1866), M. M. Noah (1785-1851), James Harper (1795-1869), James G. Bennett (1795-1872), Thurlow Weed (1797-1882), William Leggett (1802-1839), Emil Girardin (1806-1881), Francis Mahoney, "Father Prout" (1805-1866). Gamaliel Bailey (1807-1859), Par Benjamin (1809-1864), Paul de Cassagnac (1808-1880), Paul de Cassagnac (son) (1843), Louis Blanc (1811-1882), Horace Greeley (1811-1872), Parke Godwin (1816), W. S. Robinson ("Warrington") (1818-1876), W. F. Storey (1819-1885), Chas. A. Dana (1819-1897), G. D. Prentice (1802-1870), H. J. Raymond (1820-1869), George Ripley (1802-1880), Joseph Medill (1823-1899), G. A. H. Sala (1828), Auguste Vitro (1823-1891), B. P. Poore (1820-1887), T. D. A. McGee (1825-1868), Samuel Bowles (1826-1878), Murat Halstead (1829), E. S. Godkin (1831), H. Labouchere (1831), A. D. Richardson (1833), Whitelaw Reid (1837), Henry Watterson (1840), Horace White (1834), Archibald Forbes (1838), James G. Bennett, Jr. (1841), G. A. Townsend ("Gath") (1841), H. B. Carpenter (1840), J. R. Young (died 1898), Joseph Pulitzer (1847), Fred Villiers (1850), V. F. Lawson (1850).

Perhaps the most notable news-

paper correspondent of the century is "Gath"—George Alfred Townsend, born in Georgetown, Delaware, January 30, 1841. He was war correspondent of the New York

SIR EDWIN ARNOLD.

"Herald" in McClellan and Pope's campaigns, and of the "World" at the close of the war, in 1864. Since then he has been a continuous and most profuse correspondent, and has written matter for a hundred books for the daily press, besides some twenty books, several of them historical novels.

As a journalist, critic, historian and politician, Charles A. Dana, editor of the New York "Sun," achieved eminence. His manifold ability and industry placed him well in the lead of newspaper managers. He was educated at Harvard, and in 1842 joined the Brook Farm Community in its socialistic venture. In 1847 he became connected with the staff of the New York "Tribune." He attained the position of managing editor of that paper, and the development of his genius for journalism was largely instrumental in making it the leading organ of anti-slavery sentiment just before the war, with an extraordinary influence and circulation. Leaving the "Tribune" in April, 1862, he entered the service of the government, and from 1863 to 1865 was Assistant Secretary of War. He then became editor of the Chicago "Republican," which failed of success. In 1868 he organized the stock company that now owns the New York "Sun," and for over twenty-six years was actively and continuously engaged in the management of that successful journal. Mr. Dana collaborated with Gen. James H. Wilson to write a "Life of Ulysses S. Grant." He also edited "The Household Book of Poetry," and in connection with Rossiter Johnson, compiled "Fifty Perfect Poems." He died October 17, 1897.

Henry Watterson served in the

THOMAS B. MACAULAY.

Civil war in the Confederate army, and after considerable editorial service, he succeeded George D. Prentice as editor of the Louisville "Journal," and united the "Courier"

and "Times" with that paper, and has since been its editor. He is a powerful writer and speaker, and is in the front rank of the editorial profession.

Joseph Pulitzer achieved great editorial success in St. Louis, and afterward in New York as editor and proprietor of the "World." He is recognized as one of the world's great journalists.

James Gordon Bennett, Sr., founder of the New York "Herald," was one of the great journalistic forces of the century.

James Gordon Bennett, Jr., wears his father's mantle gracefully, and is a vigorous and successful force in journalism.

Joseph Medill, one of the dozen great American editors, was born in New Brunswick, Canada, April 6, 1823. After varied editorial experience he became connected with the Chicago "Tribune" in 1855. The "Tribune," for twenty-five years during which he was editor-in-chief, tells the story of his ability.

Horace Greeley, easily first of American journalists, immortalized himself and the New York "Tribune," which were for years the first editor and newspaper in America.

Murat Halstead was born in Butler County, Ohio. He was connected with several papers before 1853, when he was employed on the Cincinnati "Commercial." In 1867 he obtained control of that paper, since which time he has been one of the small group of great editors.

Whitelaw Reid (1837), the successor of Horace Greeley, was born in Xenia, Ohio, and after a brief editorial experience was a brilliant war correspondent. In 1865 he took a position on the New York "Tribune," and on Greeley's death he succeeded to the ownership and management of that great paper. He belongs in the rank of the great editors of the country.

The New York "Sun" was founded in 1833, the first successful penny paper in the world. The "Herald" followed in 1835, and the "Tribune" in 1840. Besides these publications now published that have achieved a national reputation, are the New York "Evening Post," 1801; "Youth's Companion," 1827; "Harper's Weekly," 1856; "The Nation," 1865; "Puck," 1887, etc.

McMaster, in his "History of the People of the United States," says of newspapers: "Forty-three had come safely through the long revolutionary struggle — but with few exceptions, all were printed in the large towns, and news which depended on them for circulation was in much danger of never going fifty miles from the editor's door. An interchange of papers did go on among the printers—but the papers were not received by the post-office, and it was only by rewarding the post-riders that a place was made for a dozen copies in the portmanteaus containing the letters." They were poor and mean-looking, and were printed on paper such as would now be thought too bad for hand-bills and ballads. Few came out oftener than thrice in a week, or numbered more than four small pages. Everything which now gives

A CITY PARK.

"Beyond all other centuries, the Nineteenth marks the progress of the common people."

MODERN SCULPTURE

to the daily paper its peculiar value was wanting.

"As late as 1830," says James Parton, "journalism had no existence in the United States. Newspapers were mere appendages of party, and the darling object of each journal was to be recognized as the organ of the party it supported. As to the public, the great public, hungry for interesting news, no one thought of it. Forty years ago, in the city of New York, a copy of a newspaper could not be bought for money. If any one wished to see a newspaper, he had either to go to the office and subscribe, or repair to a bar-room and buy a glass of something to drink, or bribe a carrier to rob one of his customers. The circulation of the 'Courier and Enquirer' was considered something marvelous when it printed 3,500 copies a day. The earlier editors of note in New York, such as M. M. Noah (1785-1851), James Watson Webb, and James G. Bennett, produced diminutive and meager sheets that would now scarcely be tolerated in the smallest towns. James Gordon Bennett rented a cellar, in Wall Street, in which he established his office, and on the 6th of May, 1835, issued the first number of 'The Morning Herald.' His cellar was bare and poverty-stricken in appearance. It contained nothing but a desk made of boards laid upon flour-barrels. On one end of this desk lay a pile of 'Heralds' ready for purchasers, and at the other sat the proprietor writing his articles for his journal and managing his business." Says Mr. William Gowans, the famous Nassau street bookseller: "I remember to have entered the subterranean office of its editor, early in its career, and purchased a single copy of the paper, for which I paid the sum of one cent United States currency. On this occasion the proprietor, editor, and vendor was seated at his desk, busily engaged in writing, and appeared to pay little or no attention to me as I entered. On making known my object in coming in, he requested me to put my money down on the counter and help myself to a paper, all this time he continued his writing operations. The office was a single, oblong, underground room; its furniture consisting of a counter, which also served as a desk, constructed from two flour-barrels, perhaps empty, standing apart from each other about four feet, with a single plank covering both; a chair, placed in the center, upon which sat the editor busy at his vocation, with an inkstand by his right hand; on the end nearest the door were placed the papers for sale."

A "Herald" of that date contrasted with the same sheet of to-day will show the progress of journalism in less than three-fourths of the century.

The names mentioned above are only representative of the most remarkable company of men and women composing the writers of the press. Their ability is surpassed by no equal number in any field.

Among magazines are the "Knickerbocker," the "American Review," 1815; "Godey's Lady's Book," 1830; "Graham's," "Putnam's,"

"Harper's Magazine," 1850; "Atlantic Monthly," 1857; "Scribner," "Century," 1870; "Popular Science Monthly," 1872; "Cosmopolitan," "Munsey's," and "McClure's," etc. The brilliant magazines that have been published during this century have made an epoch in American literature. The appearance of the "Atlantic Monthly," in October, 1857, marks an epoch in our literary history. There had been earlier efforts to establish a purely literary American magazine of the highest class—notably "Putnam's Monthly"—but they had all ended in failure. "Harper's Magazine" had found success through the serial novels of Dickens, Thackeray, and other English novelists, but the periodicals that depended solely on American writers, after a few years of struggle, gave up the ghost. Now the American magazines are model exponents of the best American literature.

Childhood was never discovered by Literature until the Nineteenth Century was well advanced. Before 1830 scarcely a tolerable juvenile book existed. Since then what thousands of volumes have delighted the young in natural history, science, adventure, and in fiction. There are those now living who can remember that, in their youthful days, children had next to nothing readable. What a library of volumes the last seventy years have welcomed. The lives of children have been gladdened as never before. It would be hopeless and an impossible task to name the good books for children, and their authors, that have distinguished the century. Let us give a few only of the many authors: S. G. Goodrich ("Peter Parley"), Hans Christian Andersen, Anna Letitia Barbauld, Maria Edgeworth, Walter Scott, Charles Dickens, Mrs. Ewing, the Brothers Grimm, Mary Howitt, N. Hawthorne (the "Wonderbook"), Thomas Hughes ("Tom Brown"), W. H. Ainsworth, Samuel Smiles, Louisa M. Alcott ("Little Women"), Mayne Reid, Charles Kingsley ("Water Babies"), T. B. Aldrich, W. T. Adams ("Oliver Optic"), R. M. Ballantyne, Lewis Carroll ("Alice in Wonderland"), Rebecca Clark ("Prudy Stories"), Walter Crane, James Grant, W. H. G. Kingston, Mrs. H. B. Stowe, Mrs. Burnett ("Little Lord Fauntleroy"), S. L. Clemens ("Mark Twain"), Jules Verne, J. G. Wood, Charlotte Yonge, R. L. Stevenson, Rudyard Kipling, and a multitude of others.

And what magazines and periodicals! St. Nicholas, Our Young Folks, Youth's Companion, Nursery, Every Boys' Magazine, Peter Parley, Chatterbox, Aunt Judy, Wide Awake, Atalanta, and a host besides. Truly, the boys and girls of 1900 can have no idea of the advantages they enjoy over their grandfathers and grandmothers. Juvenile literature is a creation of the century.

CHAPTER LII.

WOMAN.

UMÉ OF THE PROGRESS OF WOMAN DURING WHAT VICTOR HUGO CALLS THE WOMAN'S CENTURY"—INCREASE OF EMPLOYMENTS—IMPROVEMENT IN ER LEGAL STATUS, ETC.

IE status of Woman has been greatly elevated since 1800. Avenues of employment and tional advantages have been l to her; legal and other re- ons and disabilities have been ed, and her condition in many tant respects has advanced luring the single century than ıy preceding ones.

property rights of women have gone a great change. In this y, Rhode Island, in 1841, to have initiated the progress viding by law that a wife sepa- from her husband should own ntrol her property, solely. In wife's property and earnings secured to her, and could not ten for her husband's debts. 5 Massachusetts, and in 1848, York, followed, and extended fe's property rights. Most of tes have since enacted similar nd now give the wife the same ship as if she were single. In all the states the real estate wife cannot be sold without inder of her husband in the both signing it, but in Califor- olorado, Illinois, Iowa, Kansas, , Michigan, New York and ısin the wife's deed is good ıt the husband's signature. All the rest of her property she is free to dispose of as if she were single. In all the states a wife may make a will. In some of these she cannot by any means by her will deprive her husband of the legal share in her property which he would take if she made no will; but in a few, as in Massachusetts, she may cut off her husband's legal claim by securing his written consent thereto. The earnings of the wife belong to her in all but nine states and territories.

Modifications for the better estate of woman have taken place in England and on the continent. Says "The Congress of Women:" "Investigate as you will the legal freedom of women under the civilization of ancient Egypt, her intellectual culture in the palmiest days of Hinduism in India, the courtesy and respect shown to her in Japan, and whatever privileges are accorded to her in China; or turn to the honor paid her in the days of chivalry, and the half heathen civilization of the middle ages—you will find that the light shines only upon the woman of higher birth and gentle breeding, and that a heavy, dark cloud of ignorance, superstition, helplessness and hopelessness weighs down the women of the lower classes. But

under our modern Christian civilization the working-woman is recognized as the peer before the law of her wealthier sister, with a legal right to equal advantages of education, to equal protection of person and property, and equal freedom to use her powers for the good of herself and mankind. And where, in fact, woman's equality with man is not yet fully recognized, it is because of the survival of ancient ideas, which are to disappear very speedily. Thus we are more and more closely approaching the time when woman shall be recognized as the full legal and social equal of man, and the ideal of human as of Divine law shall be attained when 'there can be neither Jew nor Greek, there can be neither bond nor free, there can be no male or female—for ye are all one man in Christ Jesus.' "

SUSAN B. ANTHONY.

"Nearly every improvement in woman's condition has been the work of the Nineteenth Century," says Lucy Stone Blackwell: "Fifty years ago the legal injustice imposed upon women was appalling. Wives, widows and mothers seemed to have been hunted out by the law on purpose to see in how many ways they could be wronged and made helpless. A wife, by her marriage, lost all right to any personal property she might have. The income of her land went to her husband, so that she was made absolutely penniless. If a woman earned a dollar by scrubbing, her husband had a right to take the dollar and go get drunk with it and beat her afterward. It was his dollar. If a woman wrote a book the copyright of the same belonged to her husband and not to her. The law counted out in many states how many cups and saucers, spoons and knives and chairs a widow might have when her husband died. I have seen many a widow who took the cups she had bought before she was married and bought them again after her husband died, so as to have them legally. The law gave no right to a married woman to any legal existence at all. Her legal existence was suspended during marriage. She could neither sue nor be sued. If she had a child born alive the law gave her husband the use of all her real estate as long as he should live, and called it by the pleasant name 'the estate by courtesy.' When the husband died the law gave the widow the use of one-third of the real estate belonging to him, and it was called the 'widow's encumbrance.' While the law dealt thus with her in regard to her property,

lt still more hardly with her in l to her children. No married :r could have any right to hild. But the laws in regard : personal and property rights men have been greatly changed nproved, and we are very grate- the men who have done it.

e have not only gained in the that the laws are modified. en have acquired a certain nt of political power. We have n twenty states school suffrage omen. Forty years ago there out one. Kentucky allowed vs with children of school age e on school questions. We have municipal suffrage for women Cansas, and full suffrage in ning.

he last half century has gained omen the right to the highest tion and entrance to all profes- and occupations, or nearly all. result we have women's clubs, Woman's Congress, women's tional and industrial unions, noral education societies, the an's Relief Corps, police ma- the Woman's Christian Tem- ce Union, colleges for women, co-educational colleges, and the ard Annex, medical schools and :al societies open to women, n's hospitals, women in the t, women as a power in the authors, women artists, n's beneficent societies and ng Hand societies, women l supervisors, and factory in- ors and prison inspectors, women ate boards of charity, the Inter- nal Council of Women, the an's National Council, and last, but not least, the Board of Lady Managers. And not one of these things was allowed women fifty years ago, except the opening at Oberlin."

While there yet remain many vestiges of the ancient disregard of the rights of women, there are many improvements in their condition. No longer does English or American law permit the husband to assault the wife, and police matrons in attendance in police stations and prisons protect female prisoners from the indignities and even outrages that once were possible. Best of all, in most states of our country, the age of consent has been raised from ten years to fourteen, sixteen and even eighteen years. Under English common law the age was ten to twelve years. Not until 1885 did the age of consent laws begin to attract attention. One result was the speedy raising of the age in England from thirteen to sixteen years. In the United States the reform is still going on. In one state the age was seven years. Now only three states have it as low as ten years, five states have fixed the age at eighteen years, one at seventeen, eleven at sixteen, two at fifteen, nineteen at fourteen, two at thirteen, five at twelve, and three at ten.

At the beginning of the century women in their homes by hand manufactured coarse cloths, linsey-woolseys, hosiery of wool, cotton, thread, coarse fustians, jeans, muslins, checked and striped cotton and linen goods, bedticks, coverlids, counterpanes, tow linens, coarse sheetings, shirtings, toweling and table linen, and various mixtures of wool and

cotton, and of cotton and flax, not only for their own families, but in many cases for sale and even for exportation. Most of the people, men, women and children, wore clothing spun, woven and made at home by women. When the power loom and machine spinning came in, women and children began to find employment for hire, and their sphere of labor has continually enlarged. Harriet Martineau, even in 1840, found only seven kinds of work pursued by women—teaching, needlework, keeping boarding-house, working in the cotton-mills, type-setting, book-binding, and domestic service. From 1800 to 1840 this was the situation. Before the first quarter of the century had ended women and children helped in the field and did heavy drudgery in the house. From 1840 onward they have constantly entered new fields. In the classifications of industries in 1890 there are 369 different ones. Women and children are reported as being employed in 300 of them. The last census report shows that in the United States there were 3,914,711 women engaged in the gainful occupations. In agriculture, fisheries, and mining there were 679,509 women; in professional service, 311,682 women, the increase in ten years being 75.84 per cent., as against 48.53 per cent. of men. In domestic and personal service there were 1,667,686 women. In trade and transportation, 228,309. In manufacturing and mechanical industries, 1,027,525.

Within a century the educational opportunities of woman have been greatly enlarged. In continental Europe women are admitted to universities; in Italy, France, Belgium, Roumania, Norway, Denmark, Holland, Switzerland, etc., and they can have college degrees. In Great Britain, the London University, and the universities of Scotland and Ireland are open to them. In 1890, Philippa Faucett achieved the highest mathematical honors in Cambridge, England. This institution and Oxford do not admit women to lectures and degrees, but Girton, Newnham and St. Margaret's afford them every advantage that the best colleges give.

In this country most of the best institutions are open to women. Wellesley, Smith, Vassar, Bryn Mawr are solely for women. With few exceptions the principal colleges of America, such as Michigan, Boston, Cornell and Chicago, and those in Canada, are co-educational. And yet the first collegiate diploma ever granted to a woman was given by Oberlin college, in Ohio, as recently as 1838.

The keynote of progress was sounded in 1833, when Oberlin College, in Ohio, was founded. It was the first college open to both sexes.

Lucy Stone was a native of Massachusetts (1818-1893), educated in the public schools at Monson and Wilbraham academies, Mt. Holyoke seminary and Oberlin college. She married Henry B. Blackwell in 1855, but did not change her name, finding that no law required her to do so. Mrs. Stone was a well-known Woman Suffragist. Her principal works are editorials in the "Woman's

Journal," extending over twenty-two years. In religious faith she was a Hicksite Quaker, or liberal Unitarian.

The first to practice medicine in this country was Dr. Harriot K. Hunt. Her autobiographical work, called "Glances and Glimpses," is a complete statement of her struggles. She was born November 9, 1805; and her sister, Sarah Augusta Hunt, who was also a physician, was born December 25, 1808. Dr. Harriot died at the age of sixty-three, January 2, 1875, in Boston.

Elizabeth Blackwell (1821) found the doors of medical colleges closed to women, but after severe trial and repeated efforts she gained entrance to the Geneva Medical school, where she graduated with the highest honors of her class in 1847, the first woman physician in the United States. Since she opened this door, thousands of women have entered, and to-day stand in the forefront of the profession.

Among Friends there have always been recognized woman preachers. To-day there are ordained women ministers and pastors among Congregationalists, Universalists, Unitarians, Baptists, Christians, Protestant Methodists and Primitive Methodists. The Universalist and Unitarian theological schools in this country admit women students, and the theological schools of Switzerland are open to them. In all, there are in this country, some 700 authorized women ministers.

Rev. Antoinette Brown Blackwell (1825) was the first woman regularly ordained by public services in America, perhaps in the world. She was born May 20, 1825, at Henrietta, Monroe County, New York. At twenty years of age she went to Oberlin college, and joined an advanced class, and was graduated in the class of 1847.

Rev. Augusta J. Chapin was the first woman Doctor of Divinity. She is a Universalist minister. She was born in Lakeville, New York. She is a graduate of the University of Michigan, with the degree of Master of Arts. She received the degree of Doctor of Divinity in 1896.

In 1852, Maria Mitchell (1818-1889) received the degree of LL. D. from Dartmouth College; the first woman to receive that degree. She was astronomer at Vassar twenty-three years.

The first woman admitted to the bar in modern times was in this country, when Mrs. Arabella A. Mansfield, in 1869, was authorized without objection, to practice law before the Supreme court of Iowa. Twenty-five states admit women to the bar, and since June, 1869, upward of 300 women have been admitted to practice law in the various State and Federal courts, and at least one-third of these are in actual practice, some of whom practice in the Supreme court. In France, Holland, Switzerland, Canada, India, Japan, the Hawaiian Islands, women lawyers are recognized, and there seems a growing sentiment in other countries to remove all restrictions to their admission to the practice of law. Myra Bradwell, of Chicago,

established and edited, with great ability, "The Legal News."

The enlargement of the sphere of woman's activities is constantly increasing. She can be a minister, doctor, lawyer, professor, lecturer, journalist, mechanic, architect, sculptor, painter, merchant, day-laborer. In fact, whatever she chooses to undertake she is permitted to do, if not in one country, then in another.

The United States census labor bulletin, No. 99, shows that while the percentage in the increase of women in all gainful occupations since 1880 is forty-eight per cent., the percentage of this increase in manufacturing and mechanical industries alone is nearly sixty-three per cent. The total number of women in all gainful occupations is 4,000,000. Among them are pilots, sailors, locomotive engineers, plumbers, machinists, workers in iron, steel, brass, lead and zinc, boiler-makers, nailmakers, furnace-makers, roofers and slaters. They are also clerks, typewriters, stenographers, etc., instead of being restricted to housework and teaching, as was almost exclusively the case a hundred years ago.

The first law ever enacted in the interest of woman's education was in New York, in 1818. Through the earnest efforts of Mrs. Emma Willard, Governor DeWitt Clinton urged the passage of a bill to make appropriations for schools for women, as well as for men, and it was done.

Woman's right of suffrage exists to some extent in most cilvilized countries, and the borders of the privilege are constantly widening. In Italy, Russia, Sweden, Finland, Iceland, and Austria suffrage is permitted for certain offices, but not election to those offices. In Norway, school suffrage; in Sweden, since 1862, municipal suffrage and local elections; in Russia, women who are heads of households vote by proxy at municipal and local elections; in France women teachers vote for women members of boards of education; in Italy, since 1882, widows and wives separated from their husbands vote by proxy for members of parliament; in Ireland women vote for guardians of the poor; in Finland, all women except wives living with their husbands, since 1865, vote for all elective offices except one; in Iceland and Isle of Man, equal suffrage with men; in England, Wales and Scotland widows and single women vote for all officers except members of parliament; in Canada and most of the British colonies women can exercise municipal suffrage; in England women may be poor-law guardians, physicians, in government hospitals and insane asylums; in France, members of boards of education, etc.

In the United States, in Wyoming, women have full suffrage; in Kansas, municipal suffrage; in Montana, school suffrage, and can vote on expenditure of money for public purposes; in twenty-nine states some form of suffrage, such as granting liquor licenses, etc. In Wyoming, they are eligible to all offices; in Kansas, to municipal offices; in some states, members of

state boards of charities, managers of penal and reformatory institutions, overseers of poor, etc. Since 1870 clerkships of government departments have been accessible. Thus though women are not admitted to the full exercise of political rights, except in a few localities, still they possess very generally some right to vote upon local matters and to hold many executive offices. Legislative and judicial offices are not as yet granted to women, except in a very few countries and states, but the progress during a half century has been great. Among the workers in woman's enfranchisement are Laura O. Chant (1848), Emily Faithful (1835), and others herein mentioned.

Within a few years the lives of women have broadened and deepened through the medium of clubs. They have proved that the opportunities for the self-development and usefulness of woman are almost without limit. They have taught her how to apply more intelligent principles in the management of her own home and in all the affairs of life. From a condition of society in which but a few years ago a woman who joined any society but her sewing circle or a social club was conspicuous, the woman of to-day has advanced until she takes a part in the most serious undertakings for the intellectual and moral advancement and the material good of the community. Her horizon has widened and the plane of life has been made larger by her contact with other women. She has been made more humane by a knowledge of humanity's needs, and the achievements of other workers have inspired her to efforts not thought of before. The woman who has a home life has found that she may yet keep in touch with the interests of the outside world and give of her goods to those who are less fortunate. The woman who knows the treadmill of life and has seen only the other side, has learned that by co-operation her own life holds possibilities for improvement, beauty and helpfulness which she knew not until the example had been set.

It would be impossible in a work like this to record the inventions by women, of household conveniences and the minor arrangements of life. They amount to hundreds in number, and are in general use.

"Many of woman's inventions have been patented under men's names. The largest foundry in the city of Troy is run to manufacture horseshoes, one of which is turned out every three seconds. The machine which does this work was invented by a woman. A Troy foundry owner declared the best stove he ever knew was invented by a woman, but the patent was taken out in a man's name. One of the earliest mowing machines was perfected by a woman, who aided her husband in bringing that and a clover-cleaner to perfection. This was a New Jersey woman; still another New Jersey woman invented the attachment to the mowing machine, whereby the knives are thrown out of gear whenever the driver leaves his seat, thus lessening the liability to accident. The first large establishment in the country for the manufacture of but-

tons, the Willistons', was due to a woman, though it was run under a man's name. The self-fastening button is a woman's invention. The machine for making satchel-buttoned paper bags was a woman's invention, and a very important one at that; one that had long been tried for by men without success.

"Of improvements in sewing machines, woman has invented a great number, as quilting attachments, threading while in motion, attachments for sewing sails, etc. Elevators, lubricating felt for car-wheels, wood-sawing machines, designs for oil-cloth, calico, carpets, etc.," have been originated by her.

The band-box has a history. It began to be made in perfection about seventy years ago in Jaffrey, New Hampshire, by a woman named Hannah Davis, who manufactured the first nailed band-boxes in the country, and made herself rich thereby.

It was the distinguished Martha Buckminster Curtis who planted, in Framingham, Massachusetts, the first potatoes ever set in New England.

The first patent ever issued in England to an American man or woman was to Mrs. Sibylla Masters, of Philadelphia, for making straw and palmetto hats. In 1821, Sophia Woodhouse, of Connecticut, secured a patent for making bonnets of straw.

Prior to 1860 there were scarcely half a dozen patents taken out by women, and of the several hundreds now on exhibition at the Patent Office nine-tenths of them have been invented within the past twenty years. There are now patents taken out by women on agricultural implements, mining machinery, electrical contrivances, and even general railroad and mill machinery.

In 1821, Mary Lyon was the first woman assistant principal of an academy the world ever knew. In 1836 she laid the cornerstone of Mt. Holyoke Seminary. Although Latin and French were taught from the first, she waited ten years before she could get Latin included in the course, such was public opinion on woman's education. She lived to realize the fruitage of her seed sowing, and Mary Lyon and Mt. Holyoke Seminary will never be forgotten by the thousands who have attended this institution. Destroyed by fire, it was re-dedicated November 18, 1897, sixty years after its dedication.

Alice Freeman Palmer was for six years president of Wellesley College, and has since been one of its trustees and a member of the Massachusetts board of education. When girls were first admitted to the public schools of Massachusetts, in 1822, no one would have dreamed that in sixty-six years a woman would have been president of one of its most noted colleges, and a member of its state board of education.

Among the women of the United States who have devoted their lives to the work of correcting evils in the conditions of their sex, there is none better known or more highly honored than Elizabeth Cady Stanton. She was born in Johnstown, New York, November 12, 1815, and was graduated at Emma Willard's

Seminary, in Troy, New York, in 1832. In 1840 she was married to Henry Brewster Stanton.

Julia Ward (Howe) was born in New York City, May 27, 1819. Her father, a banker, gave her every advantage of a liberal education. In 1843 she became the wife of Dr. Samuel G. Howe. She had, when only seventeen years of age, produced several clever essays and reviews, and in 1852 published her first volume of poems. In 1867 she visited Greece with her husband, where they won the gratitude of the people of that country because of aid extended in the struggle for national independence. In 1868 Mrs. Howe first took part in the suffrage movement. Among her many works, the "Battle Hymn of the Republic" is, perhaps, most widely known, and most likely to remain a permanently admired masterpiece in American literature.

Susan Brownell Anthony was born February 15, 1820. Her father was a Quaker. About 1857 she became prominent among the agitators for the abolition of slavery. Her energies, however, were chiefly directed to securing equal civil rights for women. In 1854 and 1855 she held conventions in the cause of female suffrage in every county in New York, and since then has addressed annual appeals and petitions to the legislature. She was active in securing the act of the New York Legislature in 1860, giving to married women possession of their earnings, and the guardianship of children. In the same year she started a petition in favor of leaving out the word "male" in the fourteenth amendment to the United States Constitution, and worked with the National Suffrage Association to induce Congress to secure to her sex the right to vote. Between 1870 and 1880 she lectured more than a hundred times a year in all of the Northern and some of the Southern states. She is the author of "The History of Woman Suffrage," in two volumes, in which she was assisted by Elizabeth Cady Stanton and Matilda Joslyn Gage.

Mary Ashton Livermore was born in Boston, Massachusetts, December 19, 1821. She was active during the war in the Sanitary Commission, and has been foremost in the Woman Suffrage movement. Her "Story of My Life" is a work of great interest, and her public addresses have justly entitled her to be styled "The Queen of the Platform."

Representative of a large number of talented women active in public life may be mentioned Kate Field, a brilliant journalist; Sarah Hackett Stevenson, an eminent physician; Rev. Celia Parker Woolly (1848), a Unitarian preacher and novelist; Isabella Beecher Hooker (1822), an active reformer; Mary Elizabeth Lease (1853), a courageous and eloquent advocate of Woman Suffrage; Charlotte Perkins Stetson, a woman of great abilities, whose pen has contributed much to woman's advancement; Anna Elizabeth Dickinson, who was born in Philadelphia in 1842, and who was at one time a brilliant advocate of woman's rights, an anti-slavery lecturer, and one of the most eloquent of public speakers.

e has been in ill health and pri-
te life since 1892; Mrs. J. Ellen
rton Foster, who was admitted
the bar of the Supreme Court of
wa in 1872. She first practiced
alone, and afterward formed a part-
nership with her husband. She
became an enthusiastic temperance
worker, and abandoned the practice
of law largely in that interest;
Mrs. H. J. Robinson (1825—) is
author of several important works.

Mrs. Bertha Honoré Palmer was
born in Louisville, Kentucky. She
was married in 1871 to Mr. Potter
Palmer, Chicago. She has since
resided in that city. She was chosen
president of the Board of Lady Man-
agers of the World's Columbian Ex-
position, and to her office she gave
time, persistent energy, executive
ability and wide leadership, to which
in large measure is due the success
of the woman's exhibit, which ex-
celled the fondest hopes of its most
sanguine supporters.

A feature of the great Columbian Exposition in Chicago in 1893, would have been impossible a hundred years ago. The Woman's Congress was a gathering of the women of the world, among whom were many of the most notable and cultured, whose papers and addresses and personal presence gave an object lesson of woman's development and progress that impressed the civilized world. The Board of Managers and its competent president, the participants in the literary exercises, the exhibitors of the handiwork, the *ensemble*, furnished one of the most remarkable and impressive episodes in the world's progress, and demonstrated the elevation of woman during the century, beyond the power of words to describe. The papers and portraits contained in the remarkable work, "The Congress of Women," nearly 200 of the former and 300 of the latter, mark an epoch in the progress of women and of the human race. In her closing address Mrs. Palmer summed up some of the results of the contributions of the women to the great Exposition: "The results attained from the statistical investigations undertaken by the Board of Lady Managers are so interesting in their nature, that the different government agencies, which have been making original investigations for us, and tabulating the results, are themselves surprised by the facts elicited, and they willingly give us the credit for having organized new and important lines of statistical investigations, which will be immediately incorporated in the bureaus of their respective governments.

"The work of the Board of Lady Managers in these new and unexpected directions, has been a constant source of pleasure and inspiration. The material exhibits in the Woman's Building have become mere incidents, and do not at all represent the great thoughts that lie behind them. That we have been successful in creating an organization throughout the world, and in interesting the governments of the world in the condition and position of their women, is of incalculable benefit. A community of interest has been created among women in every part of the world, such as has never be-

fore existed, and women delegated by their respective governments have visited the Fair, and carefully studied not only our country and our customs, but those of every other part of the world, as evidenced by their exhibits and by their peoples, who have come to the Exposition in great numbers. The attention of all has been drawn to the Woman's Building, to the purposes for which it was erected, to the wonderful co-operation secured, and, as a result, the claims of the weaker sex have been treated with more respectful consideration than has ever before been accorded them. In the great commingling of races and interests, ideas have rapidly diffused, and many supposedly fixed conditions have been modified or changed.

"The progress of the last hundred years, while necessarily including much that is common to both sexes, has been so marked in its relations to woman as to stand out distinctly. One feature of it, which may seem very prosaic, is that which comes under the head of political economy —the vastly increased number of women who are earning their own living. The significant part of it is that they have made this advance for themselves, and that men have not made it for them. The old accepted phrase that woman is maintained by father, or husband, or brother, however agreeable, was never only partially true; and even where it was so, it was not always to the advantage of woman. The opening of facilities for self-support, caused by the progress of modern industry, has wrought a great change. Twenty years ago, of 6,000,000 women, about twenty years of age, in England and Scotland, it was found that 3,000,000, or one-half of the whole number, were special in the industries and were independent supporters; and some writers expressed the opinion that there were not 50,000 in England who were not in some manner industrial and self-sustaining. There are no census returns in this country, to give a similar class of facts; but here in Massachusetts, at least, there is no doubt the progress is greatly in advance of these English statistics. Woman is now seen and welcomed in nearly every department of labor and effort. The last fifty years have seen old barriers broken down which can never be restored, new avenues opened which can never be closed, over which her advancing step has not been so much the movement of her design, as it has been the fulfillment of her destiny. This hand of social reform has been gentle, but resistless."

Among distinguished women there are several who may be said to represent millions of their sisterhood in all ages, but who stand conspicuous among them, and glorify the century and womanhood. Along with the Catholic Sisters of Charity, and the Protestant Army Nurses, and those in all the walks of life who have lived for others, these conspicuous heroines will wear the fadeless amaranths of immortality in all the centuries to come.

Elizabeth (Gurney) Fry (1780-1845), the greatest of the friends of prisoners, was a child of Quaker lin-

ment to the religious called Friends," faithful adherent. hirteen years after marriage (in 1813), when she the mother of eight children, she visited Newgate Prison, and gan the gracious work that lasted thirty years. After her father's ath, in 1809, she had become a regular minister in the church to which she belonged. Thus, she looked upon her mission to the unfortunate women in Newgate and ewhere as part of her public uties. For thirty years she never missed an opportunity of carrying out this truly philanthrophic object. In 1830 she extended her field of labor to foreign prisons. Space fails to record the thousandth part of her eventful and interesting life. Extended particulars from her letters and diary may be met with in the excellent memoir by her daughters: how she won the fame which is so honorable to her memory, how she traversed the continent, talking with all manner of pitiable people; how she made her way into the refuges and prisons of Holland and Germany, descending into the fetid air of the jail at Amsterdam, or threading the dismal corridors in the infamous dungeons of Magdeburg; with what untiring earnestness she argued, in eloquent fragments of French, with prison authorities at Potsdam and Berlin, or encountered the perils of the plague hospital at Paris; ventured into the unsavory precincts of Saint-Lazare, and talked with the aimless loungers of La Force; how still she journeyed to La Perrache and the Maison d'Arret at Lyons, from Lyons through Nismes to Marseilles, and penetrated even to the galleys of Toulon, but everywhere bent on the one great errand of mercy to the fallen. These years are among the most beneficent and devoted ever lived on this earth, and render the name of Elizabeth Fry one of the grandest recorded in the annals of time. She began her ministry in 1810, after feeling for twelve years that God called her to this work. The results of her public labors were marvelous, and her own family of eleven children were never neglected. Hers was a model household, and her work for unfortunate women in Newgate was the beginning of prison reform which commanded the respect of the world. Seventeen European sovereigns honored themselves by honoring her. When she first entered the prisons, their condition was most revolting, and it was considered unsafe to do so without a guard. The thought of reforming these inmates of both sexes, and all grades of crime, huddled together like wild beasts, seemed the apex of madness. The keepers remonstrated with her, but the love of Christ constrained her, and with no protector save Daniel's God, she was locked in the prison with a band of fiends in human shape. As her sweet voice rang out in those grand old hymns, she awed them into silence. So heartfelt and eloquent was her appeal, that hope sprang up in the hearts of those degraded creatures, and hundreds were saved. Industries and schools were

›duced into prisons, sanitary con-
ıns improved, and the criminal
prudence of the civilized world
revolutionized in some of
aspects through her instru-
tality. In London, the Eliz-
h Fry Refuge stands to-day
fitting memorial of her life and
rs.

›rothea L. Dix (1802-1887) was
Elizabeth Fry of this country,
in many respects the most re-
kable woman of the century.
n the age of thirty-nine to
ty she devoted her life to the
ne and the prisoner, except dur-
the civil war, and then she was
ınd away the queen of nurses
e sick and wounded, the more
Florence Nightingale of Amer-
The reforms she initiated in
›ns and asylums, and the misery
alleviated, are incomparable.
transformed cages and dens of
ıent into the abodes of compara-
comfort. Her long life was one
leal beneficence. Lossing well
in his "Pictorial Field-Book of
Civil War": "The amount of
›iness that resulted from the ser-
s of this woman of delicate
ıe, can never be estimated. The
record is only in the great Book
Remembrance." And yet her
in the war was not a tithe of
enormous labors in the abodes
›aupers and prisoners in the
s of peace.

ace Darling (1816-1842).—In
family of William Darling, light-
ekeeper at Longstone, Eng-
, a daughter, Grace, was born.
lived with her parents after her
rs had married and moved away,
and her brothers had found on the mainland that employment which the little island could not furnish, until the age of twenty-two. Quiet, frail, she explored the island for objects of natural science, and no one seemed less destined than she to notoriety and fame. But one night, left alone with her parents, on September 5, 1828, a great storm shook the seas, and toward daybreak she heard the shrieks of the imperiled mariners, and besought her father to fly with her to their rescue. They reached the life-boat, but the heart of the sailor quailed at the fearful sight. Grace leaped into the boat, seized the oars, and imparted the contagion of her courage to her father, and he launched the boat. Though Grace had never before helped to manage a boat in a storm, she seemed to have supernatural strength and skill, and the nine survivors of the ill-fated "Forfarshire" were rescued. Her noble act immortalized her name, and though she shrank from publicity, the English-speaking world eulogized her name, and Grace Darling will always be synonymous with heroism and true nobility. At the early age of twenty-six she died of consumption, October 20, 1842, one of the heroines of the century.

Florence Nightingale, the immortal heroine of the Crimea (1820), was the beautiful daughter of affluence, and a woman of high culture and education, who abandoned a life of ease to help the suffering and needy. She began her blessed ministrations in London, and for several years gave her life and fortune to

the unfortunate sick. In the midst of the Crimean war, though frail in health, she offered her services as nurse, and with her associates became an angel of mercy in the hospital wards of Scutari. In the Crimean war 2,600 British soldiers were slain in battle, and 18,000 died in hospital. Little care was bestowed on the sick and wounded till she came, and she was so loved that the soldiers kissed her shadow as it fell on their couches. Declining any personal testimonial, the Government founded in her name the Saint Thomas Hospital, with $250,000. Her life has been one long benefaction, richly deserving Longfellow's eulogy.

Clara Barton was one of the heroines of the American civil war, and when the war was over she organized the "Bureau of Records of Missing Men in the Armies of the United States," which was found afterward to be an enterprise of great value to the Government, as well as to the friends of the soldiers. She induced the Government to lay out cemetery grounds at Andersonville, placing head-boards when possible to identify the graves. During the French and Prussian war she was in Europe, assisting the women of the nobility in their efforts for the wounded soldiers, and doing noble service for humanity in a foreign, as she had already done in her native land. She organized the Red Cross, and distinguished herself by flying to scenes of devastation by flood, fire or famine, to minister to the needy, and in the war between the United States and Spain she became a veritable Angel of Mercy in Cuba, and the West Indies.

The name of Clara Barton will forever shine among the women who won a deathless fame in the days that called for loyal and philanthropic effort. Her work of humanity has moved on many lines. She has been a teacher and educational reformer; a clerk in government service, removed for her devotion to freedom, and re-instated by Lincoln; a representative of international peace, a public lecturer, reciting the story of human suffering and relief; a benefactor of communities in times of calamity; a ministering presence to sick and wounded soldiers and prisoners in the civil war; a director of helpful agencies in the Franco-Prussian struggle, and in the horrors of the French Commune; a pioneer for a better administration of medical and hospital departments; a friend of more humane recognition of noncombatants; the protection of hospital supplies and the promotion of relief work; an advocate of the Red Cross Association, as part of our national polity, having won for it Congressional recognition, and of which she was appointed president in America by Garfield; and a most influential and beneficent factor in the philanthropies of our late war with Spain. For these broad and varied services she has been honored throughout the civilized world. Royal hands have decorated her, and the hearts of the common people have arisen and called her blessed.

What a great work the Red Cross could have wrought in our civil war! It is true that the Confederate States

1. Louisa M. Alcott. 2. Queen Wilhelmina. 3. Queen Victoria.
4. Jane Austen. 5. Alice Cary.
6. Sarah M. Fuller. 7. Madame Recamier. 8. Frances H. Burnett.

1. Michael L. Munkacsy. 2. J. L. Meissonier. 3. Rosa Bonheur.
4. W. A. Bougereau. 5. Jules Breton.
Sir Edwin Landseer. 7. Edouard Detaille. 8. L. Alma-Tadema.

d not have been a party to the ty, not being a recognized na- but the Red Cross societies of ral nations could not have been ed from carrying succor to ›y, Belle Isle and Andersonville ›ns. Miss Barton was one of ›rincipal, if not the first, among American Sisters of Charity, in war of the Rebellion.

ıe magnificent creation of the ury, the Red Cross, is one of its t beneficent products. It is not :iety; has no members or meet- or dues; only its staff officers. , in the language of Clara Barton 6), its presiding genius and crea- ›f the American Red Cross: "A .t treaty, one of the greatest ever red into, and the nations that parties to it are Great Britain, many, France, Belgium, Russia, tria, Sweden, Norway, Turkey, ece, Spain, Italy, Servia, Persia, Roman States, Switzerland, the ted States, Venezuela, Bolivia, e, Peru, Argentine, Japan, and :r governments to the number of y or more. They have bound nselves to regard all sick and nded persons in time of war as tral, and to care for one an- :r's disabled as they do for their . A sick or wounded soldier, to .tever army he may belong, into .tever hands he may fall, is a Red ss subject. His nationality is ged in the humanity of the ty, and he is tenderly cared for. ured, he is sent to his home as a -combatant. No days of suffer- relieved only by death, can en- even if his comrades have passed ond reach of him, leaving him to the neglect or cruelty of the enemy, as in the days gone by. No starvation, no death from neglected disease, can happen within the boundaries of a treaty nation. The civil arm of the Red Cross can extend through the lines to reach the suffering, although the lines be bristling with the engines of war.

"The prime thought that inspired the promoters of the treaty, was the unavoidable insufficiency of the military hospital service. They interested the officials of the Swiss government, and with General Dufour, commander-in-chief of the Swiss army, at its head, a committee was appointed February 9, 1863, to forward the movement. That date marks the beginning of the Red Cross, although the great honor of conceiving the ideas that culminated in the treaty of Geneva, in August, 1865, belongs to Henry Dunant, who had been the unhappy witness of terrible and needless suffering by the wounded at the great battle of Solferino, June 24, 1859.

"The labors of the committee resulted in a formal international conference, in October, 1863, and the final convention in August, 1864. So delicate and arduous was the work before the delegates of these great nations, in convention assembled for the purpose of mitigating the severities of war—men whose energies had previously been given to the mutilating of men and the conquests of war—that a fortnight was consumed in their deliberations. But it was the greatest fortnight's work ever known. The great nations of the earth had been con-

quered by a humane idea. War had been robbed of its most barbarous aspects. It had been solemnly agreed that henceforth one common flag should be the symbol of mercy, and that wherever it floated there should the fallen heroes find friends and tenderness, there should they be secure against the further horrors of war.

"By the terms of the treaty, the hospital flag of every nation must be a red Greek cross on a white ground, and every person, ambulance or other part of the service must be so designated.

"The Red Cross flag has no Christian meaning in the sense that many suppose. It is broader than Christianity itself, because it has neither prejudice nor bounds; Christian, Mohammedan and pagan are the same in the eyes of the Red Cross.

"The first war to bring the treaty into practical operation was that of 1866 in Germany, Austria and Italy. Austria had not yet joined, but her citizens raised and applied nearly half a million dollars. Italian societies raised nearly $50,000. French and Swiss societies aided, this being the first instance of neutral aid.

"Germany's societies were fully prepared, and more than $3,000,000 was applied, and 500 volunteers, men and women, were employed. The results of this war fully proved the incalculable value of organized authorized civil aid.

"Next came the Franco-Prussian war and the commune, 1870-1871. In Germany more than 2,000 committees arose at once, with a central committee at Berlin. More than $14,000,000 was raised. Hospitals, hospital trains, and preparations on the grandest scale were organized. France was not so well prepared, but upward of $2,000,000 was expended, and more than 100,000 wounded were cared for. Neutral societies also rendered great aid.

"One striking instance was that of 85,000 French soldiers, who peacefully invaded Switzerland in a famished condition, ten per cent. of them being sick. Their every want was provided for by the Red Cross of Switzerland. The international committee asked for and obtained from Germany 2500 incurable French soldiers, supplied all their wants on their way through Switzerland, and returned them to their homes.

"The wars of 1876-78, involving Turkey, Servia, Montenegro, Greece and Russia, furnished the next scenes of activity. The work of the Russian Red Cross was the most notable. Regarded with jealousy, first by the military, it was soon solicited to take control. It raised nearly $17,000,000 and applied more than $13,000,000 of it. In Turkey the Red Cross emblem found its first obstruction. The Turkey soldiers regarded it from a religious point of view, and so strong was their prejudice that a red crescent had to be substituted by that society.

"The latest display of the Red Cross work has been in the Japanese army. How frequently we hear it remarked that the Japanese displayed such astonishing mercy and civilization, that they are so quick to adopt the ideas of more advanced nations, etc. In 1886, Japan joined

with the Red Cross nations. ruler, the mikado, became a lent of the Red Cross society civil capacity, and therein he secret of Japan's wonder- evelopment in humane ideas. as been an apt scholar, and vedly received the commend- s of the world. Picture, 1 can, the scenes that would ensued in this year in the ab- of the kindness and mercy ated by the Red Cross.

our country the war signal has een heard since 1882, when we ed the treaty, but the elements wought sad destruction. Fore- g these conditions, I asked of her societies, through the in- tional head, the privilege to le calamities other than war I organized the American nal Red Cross. My request ordially granted and hailed with siasm. Other nations have adopted it.

need only tell in a few words wn work. It includes thirteen of disaster in as many years. ls, famines, fires, epidemics, storms have caused the suffer- and more than $1,000,000 has applied in the aggregate by the g hands of those that have for ost part volunteered their ser- in behalf of the great cause of nity."—Written by Clara Bar- President of the American Na- l Red Cross.

woman is more highly honored ghout the civilized world than Barton—and justly so, for no woman has devoted her life to ler purpose and carried it out with such unswerving fidelity and rare self-sacrifice. Her mission has been world-wide. In the civil war her influence was potent on every battlefield from Bull Run to Appomattox. Her soothing hand was laid upon the brow of the wounded, and lifted the head of the dying on both sides in the Franco-German war. She organized and conducted the relief of the suffering Armenians, in 1896, and, a little later, hastened to aid the starving reconcentrados in Cuba, continuing her efforts throughout the conflict which followed. For a full generation she has stood, and still stands, a grand exemplar of the broadest humanitarianism. Wherever war, pestilence, fire, flood or famine has touched the human race to shatter and destroy, Clara Barton has appeared to soothe and save. Her supreme services have been widely recognized. She wears the Iron Cross of Germany, the Gold Cross of Baden, and other insignia bestowed upon the good and brave, yet none of these decorations are needed to distinguish her as a woman of mark. She has been chastened and sanctified by the whole world's suffering and stands a shining figure in the century.

Dorothy Pattison (1832-1878), "Sister Dora," was daughter of an English clergyman. Her early years were spent in caring for an invalid mother, but at twenty-nine years of age she began her life of philanthropy as a teacher in a school in Buckinghamshire. After three years of service she entered a sisterhood, "The Good Samaritans," in 1864, where she remained, devoting

her life to the poor, eleven years. During the rest of her life she was untiring in hospitals and the haunts of the poorest of the poor. "Sister Dora" was regarded as an uncanonized saint by thousands of the unfortunate sick and poor, with whom she toiled "for the love of God and in the name of Christ." Physically beautiful, morally brave, endowed with almost superhuman strength, she gave one of the rarest exhibitions of a life devoted to humanity "in His name." She was a typical philanthropist.

Ida Lewis, the American Grace Darling, was born in Newport, Rhode Island, in 1842. She has rescued sixteen persons from drowning, and was only a slight girl of seventeen when her first rescue was made, a very daring one, of the crew of a boat upset near the light-house in a storm. The next morning she rowed them over to Fort Adams, whence an attempt had been made to launch a boat but had been abandoned as hopeless. Many similar feats of bravery have followed. The United States Government recognized the heroism of Miss Lewis and bestowed upon her a gold medal of the first-class, the first ever given to a woman. The Humane Society of Massachusetts has given her a silver medal, and the Live-Saving Benevolent Society of New York has done the same. Her snug little home is filled with testimonials of recognition of her heroism. She is one of the happiest of Women.

To these might well be added a long catalogue of heroines who have glorified humanity, and shed new luster on the name of Womanhood.

When interviewed as to the greatest discoveries of the Nineteenth Century, the famous actress, Ellen Terry, said: "The development of individuality, especially among women."

Frances E. Willard said: "The greatest discovery of the Nineteenth Century is the discovery of Woman by herself."

Victor Hugo, not inaptly characterized the Nineteenth as Woman's Century.

HARRIET BEECHER STOWE.

[Born 1812. Died 1896.]

At the mature age of forty Mrs. Stowe took up her pen to write what proved to be the greatest book of the century, with probably little or no idea of the extraordinary effect that it was destined to produce,—that her work was, in fact, the weapon by which slavery in the United States should receive its death blow. This is not saying a word too much for the influence that effort of genius, "Uncle Tom's Cabin," exerted upon the public mind; for what statesmen, politicians, political economists, with all the agitators of the antislavery school, had so far failed to bring about, Mrs. Stowe did almost with a stroke of the pen.

CHAPTER LIII.

MEN AND WOMEN OF NOTE.

ORS — THEOLOGIANS — SCIENTISTS — STATESMEN — ORATORS — GENERALS— NAVAL HEROES—JURISTS—THE AMERICAN PRESIDENTS—AND SUCH HEROES AS L'OUVERTURE, KOSCIUSKO, BOLIVAR, BOZZARIS, JOHN BROWN, KOSSUTH.

URING the last hundred years all professions, and all positions in life have been filled by and women whose rank has led or surpassed that of those in age. The bare mention of their es, with date of birth and death me of the more prominent, will ate the splendid array.

CTORS.—No century has ever led the present in number and ty of its actors. Among them Mary Anderson (1859—), Law- e Barrett (1838-1891), Edwin h (1833-1893), Sara Bernhardt 4—), Lucius Junius Booth ier) (1796-1852), R. M. Cheri 4-1862), Charlotte S. Cushman 6-1876), B. C. Coquelin (1841—), . Davenport (1816-1877), C. A. iter (1824-1879), E. R. Felix hel) (1820-1858), Edwin Forest 6-1872), Elizabeth Inchbald 3-1821), J. H. Hackett (1800-), Henry Irving (John H. Brod-) (1838—), Fanny Janauschek o—), Joseph Jefferson (1829—), und Kean (1787-1833), Charles Kean (1811-1868), Ellen (Tree) n (1805-1880), Laura Keene (1820-), Charles Kemble (1775-1854), ices A. Kemble (1811-1893), P. Kemble (1757-1823), Lillie gtry (1852—), W. C. Macready (1793-1873), Mary J. ("Maggie") Mitchell (1832—), Helena Modjeska (1843—), Clara Morris (1850—), James E. Murdoch (1811-1893), L. A. Neilson (1850-1880), Adelaide Ristori (1821—), T. Salvini (1830-1896), Mary F. Scott-Siddons (1848—), Sarah K. Siddons (1755-1833), E. A. Sothern (1830-1881), Ellen A. Terry (1848—), F. J. Talma (1763-1826), Geo. Vandenhoff (1820—), etc.

THEOLOGIANS. — No master mind in theology to rank with Augustine has appeared in the Nineteenth Century, and if it should be thought that Jonathan Edwards (1703-1758) in America should be regarded as the most eminent theologian this country has produced, there are others who have risen toward his altitude in the present century both in Europe and America. A few of a great number may here be named: J. A. Alexander (1809-1860), Hosea Ballou (1771-1852), F. C. Baur (1792-1861), Lyman Beecher (1775-1863), Helen Blavatsky (1835-1891), George Bush (1796-1860), O. A. Brownson (1803-1876), Horace Bushnell (1802-1876), Alexander Campbell (1786-1866), William E. Channing (1780-1842), Thomas Chalmers (1780-1847), Adam Clarke (1762-1832), James F. Clarke

(1810-1888), J. W. Colenso (1814-1883), A. Comte (1798-1857), Joseph Cook (1838—), Mary Eddy, Charles Hodge (1797-1878), Mark Hopkins

PRINCE BISMARCK.

(1802-1887), Samuel Hopkins (1721-1803), J. McCosh (1810-1894), James Martineau (1805—), J. H. Newman (1801-1890), Andrews Norton (1786-1853), Theodore Parker (1810-1860), H. E. G. Paulus (1761-1851), P. Schaff (1819-1897), Moses Stuart (1780-1852), D. F. Strauss (1808-1874), David Swing (1830-1894), P. Tamburini (1737-1827), Leonard Woods (1774-1854).

SCIENTISTS AND NATURALISTS.—Among the thousands whose lives have been devoted to science and whose names rank high on the rolls of scientists are: L. J. R. Agassiz (1807-1873), J. J. Audubon (1780-1851), S. F. Baird (1823-1887), J. H. Balfour (1808-1884), Joseph Banks (1743-1820), A. Bonpland (1773-1858), William Buckland (1784-1856), W. B. Carpenter (1813-1885), A. P. de Candolle (1778-1841), John Cassin (1813-1869), J. F. Champollion (1791-1832), (Chevalier Bunsen pronounces his discovery of the Egyptian alphabet, in 1822, the greatest of the century), George Catlin (1796-1872), E. Coues (1842—), F. G. C. L. D. Cuvier (1769-1832), who, in 1817, published his "Regne Animal" which revolutionized zoological classification, and has even yet been superseded only in details; J. D. Dana (1813—), Wilson Flagg (1805-1884), John Fleming (1785-1857), Edward Forbes (1815-1854), Asa Gray (1810-1888), Isadore Geoffroy St. Hilaire (1805-1861), P. H. Gosse (1810-1888), A. A. Gould (1805-1866), T. W. Harris (1795-1856), H. L. F. Helmholtz (1821-1894), J. D. Hooker (1817—), W. J. Hooker (1785-1865), R. Jameson (1774-1854), A. de Jussieu (1797-1853), A. L. de Jussieu (1748-1836), William Kirby (1759-1850), Samuel Kneeland (1821—), I. A.

DANIEL WEBSTER.

Lapham (1811-1875), Mrs. Lincoln, John Lubbock (1834—), H. Lecoq (1802-1871), J. L. Le Conte (1823-1883), John Lindley (1799-

1865), Sven Nilsson (1787-1883), T. Nuttall (1786-1859), C. V. Riley (1843—), T. Say (1787-1834), M. J. Schleiden (1804-1881), Benjamin Silliman (1779-1885), James Smithson (1754-1829), W. Spence (1783-1860), John Torrey (1796-1873), Alex. Wilson (1766-1813), Alphonso Wood (1810-1881).

STATESMEN.—Among the statesmen who have left their mark on the century are: Charles Francis Adams (1807-1886), Samuel Adams (1722-1803), Julius Andrassy (1823-1890), T. H. Benton (1782-1858), K. O. Bismarck-Schönhausen (1813-1898), J. G. Blaine (1830-1892), F. P. Blair (1791-1875), Henry Brougham (1779-1868), Simon Bolivar (1783-1830), John Bright (1811-1889), John C. Calhoun (1782-1850), George Canning (1770-1827), Lewis Cass (1782-1866), E. Castelar (1832), R. S. Castlereagh (1769-1822), C. B. Cavour (1810-1861), Richard Cobden (1804-1865), Nathan Dane (1752-1835), Jefferson Davis (1808-1889), Benjamin Disraeli (1805-1881), J. T. Meagher (1823-1867), W. E. Gladstone (1809-1898), Salmon P. Chase (1808-1873), Zach. Chandler (1813-1879), S. A. Douglass (1813-1861), J. F. C. Ferry (1832), Hamilton Fish (1808-1893), Albert Gallatin (1761-1849), L. M. Gambetta (1838-1882), "Creator of the French Republic," F. J. P. Grévy (1807), John P. Hale (1806-1873), Alex. Hamilton (1757-1804) William Huskisson (1770-1830), J. Jay (1745-1849), H. P. F. Landsdowne (1780-1863), Edward Livingston (1764-1836), J. S. C. Lyndhurst (1772-1863), T. B. Macaulay (1800), Jere. Mason (1768-1848), W. L. Melbourne (1779-1848), Gouverneur Morris (1752-1816), Robert Morris (1734-1806), R. M. de Narvaez (1800-1868), Louis Napoleon (1808-1873), Daniel O'Connell (1775-1847), Robert Peel (1788-1850), H. J. T. Palmerston (1784-1865), William Pitt (1759-1806), Timo Pickering (1745-1829), C. C. Pinckney (1746-1825), Josiah Quincy (1772-1864), John Randolph (1773-1833), Lord John Russell (1792-1878), P. M. Sagasta (1827), R. A. Salisbury (1830), W. H. Seward (1801-1872), John Sherman (1823), E. M. Stanton (1814-1869), Charles Sumner (1811-1874), Silas Wright (1795-1847), Daniel Webster (1782-1852), Lord Wellington (1769-1852), William Wilberforce (1759-1833).

Abraham Lincoln (1809-1865). It is impossible in this volume to give an adequate presentation of the great man, second, if not in some respects first, among Americans. Born in the lowest poverty, rail-splitter, pilot, postmaster, legislator, president, emancipator, martyr, he achieved the veneration of mankind by his own abilities and virtues, and is to-day no doubt the best beloved of all the men of modern times. Only in America, only in the Nineteenth Century was he possible, and in that century he stands its ripest and noblest product and exponent. As George Bancroft well says: "He finished a work which all time cannot overthrow. He was followed by the sorrow of his country to his resting-place in the heart of the Mississippi Valley, to be remembered through all time by his countrymen, and by all the peoples of the world."

c f poverty; the great lawyer; the consummate statesman; his country's savior; the liberator of a race; the greatest man of the century, perhaps in modern times.

HENRY CLAY.

Prince Otto von Bismarck (1815-1899) was the greatest German, and one of the greatest heroes of any race, whom this century has produced. He was the greatest, in the sense that he was the most practical statesman, the man who knew how to grasp all the elements in the very complex surroundings of his nation during the years of its birth struggles, and to weave them all together into one great system from which he drew a policy that represented not some isolated party of his countrymen, but truly the whole country with all its parties. For this reason he has accomplished more in the field of world-politics than any other man.

Among the statesmen who have sought to promote the interests of Ireland are Michael Davitt (1846), John Dillon (1851), T. M. Healey (1855), C. S. Parnell (1846), William O'Brien (1852), T. P. O'Connell (1848), and T. F. Meagher (1823-1867).

William Ewart Gladstone (1809-1898) stood for more than half a century as the great representative of reform in the British government. As the leader of the Liberals in parliament and four times head of the government, he was able to accomplish more than any other living man for the purification, liberalization and strengthening of the British Empire, and was the most admired man in the world for fifty years. His wisdom, his honor, his vast learning and critical power, his strength and his fine personality all combined with the memory of the great accomplishments of his life to place him supreme among his fellows, and make him in truth "the grand old man" of a great nation. Gladstone was a great orator as well as a great statesman. His various

CHARLES SUMNER.

debates on political and financial questions, both in parliament and on the public stump, are masterpieces of eloquence and powerful instruments of conviction.

ORATORS.—Oratory, as Emerson said of eloquence in anti-slavery meetings, is "dirt cheap" in this country, as in Europe. It is doubtful whether any of the ancients surpassed some of the moderns, but whether so or not eloquence is far more common than formerly. As with authors, so with orators, they are a hundred to one of those of former days. The spirit of the age and the occasion has evolved and developed them. Tradition and general consent award the palm of great eloquence—oratory of the first class—to Henry Clay (1777-1852), Daniel Webster (1782-1852), Sargent S. Prentiss (1808-1850), Thomas Erskine (1750-1823), Wendell Phillips(1811-1884), C. J. Fox(1749-1806), H. W. Beecher (1813-1887), Edwin H. Chapin (1814-1880), John B. Gough (1817-1886), William Pitt(1759-1806), Edward Everett (1794-1865), Louis Kossuth(1802-1894), W. E. Gladstone (1809), J. P. Curran (1750-1817), J. N. Maffitt (1795-1850), Daniel O'Connell (1775-1847), John Bright (1811-1889), Richard Brinsley Sheridan (1751-1816), Rufus Choate (1799-1859), R. J. Ingersoll (1833-1899), Fisher Ames (1758-1808), Aaron Burr (1756-1836), T. Corwin (1794-1865), C. M. Depew (1834), Benjamin Disraeli (1805-1881), Frederick Douglass (1817-1897), Henry Grattan (1750-1820), R. Y. Hayne (1791-1840), Edward Irving (1792-1834), A. M. L. Lamartine (1792-1869), Charles Loyson (Pere Hyacinthe) (1827), E. D. de Pressensé (1824-1891), F. D. E. Schleiermacher (1768-1834), C. H. Spurgeon (1834-1892), John Summerfield (1798-1825).

GENERALS.—Napoleon Bonaparte (1769-1821) was probably the greatest military genius who ever lived, unless Cæsar was his superior. Some of the dates he immortalized during the present century, are: June 14, 1800, he defeated the Austrians at Marengo; on August 2, 1802, he became consul for life, and on May 18, 1804, emperor. On November 13, 1805, he entered Vienna, and on December 2d he gained the great victory of Austerlitz over the Russians and Austrians, and on October 14, 1806, that of Jena over the Prussians, entering Berlin on October 27th. On February 7 and 8, 1807, he was victorious over the Russians at Friedland. On May 12, 1809, he again entered Vienna. In conflict with Austria he lost the battles of Aspera and Essling, on May 21 and 22, 1809, but was successful at Wagram on July 5th and 6th. A victory, but with heavy loss to the victors, was gained over the Russians at the Borodino, on September 7, 1812. On the 14th he entered Moscow, from which he began his disastrous retreat on October 19th. The battle of Beresina was on November 26th and 27th. He was victorious over the Russians and Prussians at Lützen on May 2, 1813, and at Bautzen on the 21st, but was decisively defeated by the Russians and Prussians at the great battle of Leipsic on October 16th, 18th and 19th. On April 5, 1814, he renounced the thrones of France and Italy, and consented to have his rule limited to the island of Elba. Reappearing in France on March 1,

1815, he was decisively defeated by Wellington at Waterloo on June 18, 1815, and, surrendering on July 15th to the English, died in exile at St. Helena, on May 20, 1821.

HENRY WARD BEECHER.

Arthur Wellesley, Lord Wellington (1769-1852), the great conqueror of Napoleon, wrote his name in unerasable letters on the pages of history, and will always rank as one of the half-dozen great generals of the ages.

General Gilbert Motier LaFayette (1757-1834) gave his fortune and his invaluable services to this country, and was a great factor in accomplishing American independence. He was the hero of two continents. In the estimation of the American people he ranked with Washington. After the Revolutionary war he returned to Europe and suffered from tyrants there. He made several visits to America, and the American people never wept over any man as much as at the sight of LaFayette. One of his last acts in this country was to lay the corner stone of Bunker Hill monument. He lived to be the last surviving major general of the American revolution. America and France went into mourning for this great man of two continents. His name will ever brighten the roll of honor.

Distinguished among the generals of the century in Central and South America are P. Diaz (1830), J. Alvarez (1790-1864), A. L. de Santa Ana (1798-1876).

Among the great generals of the century in Europe, besides those mentioned, are: N. J. Soult (1769-1851), H. K. B. von Moltke (1800-1891) G. L. von Blücher (1742-1819), F. E. Todleben (1818-1884), M. Ney (1769-1815), C. J. Napier (1782-1853), Lord J. H. F. S. Raglan (1788-1855), Colin Campbell (1792-1863), F. A. Bazaine (1811-1888), J. B. J. Bernadotte (1764-1844), F. C. Canrobert (1809), J. T. B.

JAMES G. BLAINE.

Cardigan (1797-1868), L. V. E. Cavaignac (1802-1857), Henry Havelock (1795-1857), J. Lannes (1769-1809), E. H. K. Manteuffel (1809-1885), M. T. T. Melikoff (1826-

1888), C. J. Napier (1782-1853), A. Niel (1802-1869), M. E. P. M. McMahon (1808), G. J. Wolseley (1833), Charles G. Gordon (1833-1885), Alfred zu Windichgrätz (1787-1862).

Nicholas Pavlovitch Ignatieff (1832) is now the foremost general and diplomatist in Russia. His first rise in life was with his father, Count Paul Ignatieff, who won the friendship of Nicholas I, and Emperor Alexander II, who was the godfather of the present statesman. Thus Ignatieff had every advantage of birth and imperial assistance, and after three years in the military academy, he was appointed a staff officer. After some useful service in the Crimea, he retired from the army and entered the diplomatic department. He was sent at once as an attaché of the embassy at London. He was promoted a colonel and aide-de-camp to the czar, and in 1858 was sent on a special mission to Khiva and Bokhara. After that Ignatieff found honors and fame coming quickly and thickly upon him. He was made a major general in the czar's suite, and sent as plenipotentiary to Pekin in 1860.

Most of the generals of the American Revolution, including the greatest of them all, the immortal Washington, belong to the eighteenth century. Some of them, however, lived on into the nineteenth. Such were Henry Knox (1750-1806), Benjamin Lincoln (1733-1810), John Stark (1728-1822), T. Sumter (1734-1832), etc.

Federal Generals in the civil war, 1861-1865: Winfield Scott (1786-1866), N. P. Banks (1816-1894), Robert Anderson (1805-1871), E. D. Baker (1811-1861), J. C. Frémont (1813-1890), G. A. Custer (1839-1876), G. G. Meade (1815-1872), H. W. Halleck (1815-1872), G. H. Thomas (1816-1870), A. E. Burnside (1824-1881), B. F. Butler (1818-1893), John M. Palmer (1817), J. Kilpatrick (1836-1881), W. S. Rosecrans (1819-1898), W. T. Sherman (1820-1891), John Pope (1822), J. F. Reynolds (1820-1863), J. F. Porter (1822), A. Pleasanton (1824-1897), N. A. Miles (1839), Nath. Lyon (1819-1861), U. S. Grant (1822-1885), G. B. McClellan (1826-1885), R. J. Oglesby (1824-1899), John A. Logan (1826-1886), P. H. Sheridan (1831-1888), O. O. Howard (1830), John M. Schofield (1831), A. D. McCook (1831), W. S. Hancock (1824-1886), Wesley Merritt (1836), Daniel Sickles (1823), R. A. Alger (1836), Phil. Kearney (1815-1862), F. J. Porter (1822), J. B. McPherson (1828-1864), John E. Wool (1789-1869), H. W. Slocum (1827-1894), E. V. Sumner (1796-1863).

Confederate Generals: John T. Morgan (1824), R. E. Lee (1807-1870), J. B. Magruder (1808-1871), J. S. Marmaduke (1837-1887), Robt. Toombs (1810-1885), J. E. Pickett (1825-1875), John B. Gordon (1832), John B. Hood (1831-1879), G. J. Pillow (1806-1878), Wade Hampton (1818), J. C. Pemberton (1814-1881), L. Polk (1806-1864), S. Price (1809-1867), J. E. B. Stuart (1833-1894), F. K. Zollicoffer (1812-1862), James Longstreet (1821), John S. Mosby (1833), Braxton Bragg (1817-1876), P. G. T. Beauregard (1817-1893), J. C. Breckenridge (1821-1875),

A. Early (1818-1894), A. P. Hill 25-1865), T. J. Jackson (1826-3), A. S. Johnston (1803-1862), E. Johnston (1809-1891), R. S. ell (1818-1872).

Robert E. Lee (1807-1870), the great Confederate general, is ranked by many competent military judges among the greatest military geniuses. He fought a losing fight, but displayed courage of the highest order, and a commanding military genius.

Thomas J. Jackson (1824-1863), "Stonewall," was one of the great Confederate heroes,—an ideal corps commander, equaling in abilities the greatest of chieftains in ancient or modern times.

U. S. Grant (1822-1885), ranks with Cæsar, Napoleon, Wellington. His name is synonymous with courage, magnanimity, modesty, and greatness of the highest order. He belongs with Washington and Lincoln.

William T. Sherman (1820-1891), was rated by General Grant as his own superior, but unquestionably he was one of the most consummate military geniuses who ever lived.

Philip H. Sheridan (1831 - 1888), was the right arm of General Grant, —the irresistible commander—one of the three Federal captains of the first rank, Grant, Sherman, Sheridan.

Wade Hampton was born in Columbia, South Carolina, March 28, 1818. He was graduated at the University of South Carolina and afterward studied law. At the beginning of the civil war he enlisted in the Confederate service as a private, but soon raised a command, which was known as "Hampton's Legion," and won distinction in many engagements. He was several times wounded, and attained the rank of lieutenant-general in 1864.

Oliver Otis Howard was born in Leeds, Maine, November 8, 1830; graduated at West Point in 1854; took colonelcy of the Maine First in the civil war; made brigadier-general after Bull Run; lost right arm at Fair Oaks; major-general in November, 1862. One of the great names of the civil war.

James Longstreet, born in Hamburg, South Carolina, January 8, 1821, graduated from West Point in 1842. He was distinguished in the Mexican war, and in 1861 resigned his commission and was commissioned brigadier-general in the Confederate service. He was a brave general, and since the war has done much to advance the interests of the Union.

Alexander McD. Cook, born in New Lisbon, Ohio, April 22, 1831, graduated at West Point in 1852, was colonel of the Ohio First, was made major - general for distinguished services at Shiloh. One of the bravest of our heroes.

Wesley Merritt, born in New York City, June 16, 1836, graduated at West Point in 1860, entered the Federal army, and was rapidly promoted until he was made major-general of volunteers. He was commissioned brigadier-general in the regular army. An ideal soldier and officer.

John McAllister Schofield, born in Chautauqua, New York, September 29, 1831, is a West Point gradu-

ate of 1853, and being in St. Louis at the outbreak of the rebellion, became chief-of-staff to General Lyon. He was made major-general of volunteers in 1862, and in 1864 commanded Sherman's left wing in the Atlanta campaign. He became secretary of war in 1868, and was commander of the army on the death of General Sherman. He was one of the great generals of the war.

Daniel Edgar Sickles, born in New York, October 20, 1823, became a lawyer, politician, member of Congress from 1857 to 1861. February 27, 1859, he shot Philip Barton Key in the streets of Washington. He entered the army in 1861, as colonel, and was promoted to major-general. He lost a leg at Gettysburg. Since the war he has held high trusts, and is a hero in peace and war alike.

John B. Gordon, born in Georgia February 6, 1832, descended from revolutionary ancestry, and inherited their military abilities. He was practicing law when the civil war began, and entered the Confederate service as captain. He fought with great valor through the war, and received the commission of general. He was eighteen years in the United States Senate, from 1873 to 1885, and from 1890 to 1896, and was twice elected governor of Georgia. He won a brilliant record in war and in peace.

John Tyler Morgan, born in Athens, Tennessee, June 20, 1824, entered the Confederate service in 1861, as private, and rose to the rank of brigadier-general. Since 1876 he has been in the United States Senate, from Alabama.

Russell Alexander Alger, born in Lafayette, Ohio, February 27, 1836, distinguished himself for coolness and courage in the war, and was breveted major-general. Since the war he has been successful in business, and has served as governor of Michigan. He was commander-in-chief of the Grand Army, in 1890; and secretary of war under President McKinley.

Nelson Appleton Miles, born August 8, 1839, "the great Indian fighter;" has a brilliant military record, and was (in 1898) commander of the army in place of General John M. Schofield, retired. Head of the army in the war with Spain, 1898. Rose from the ranks.

Richard James Oglesby (1824-1899) removed to Illinois in early life, entered the Mexican war, became colonel of an Illinois regiment, and was made major-general for service at Corinth. He has served as governor, and United States Senator of Illinois, and is one of her greatest sons.

John McAuley Palmer, born in Kentucky, September 13, 1817, removed to Illinois in early life, and entered the Federal army as colonel of the Illinois Fourteenth. He was commissioned brigadier-general, December 20, 1861, and major-general, November 29, 1862. He has served as governor, and United States Senator for Illinois.

William Starke Rosecrans, born in Kingston, Ohio (1819-1898), was graduated at West Point in 1842. He resigned the rank of lieutenant in 1854, and entered on a business life. At the outbreak of the civil war he

volunteered as aide to General McClellan, and later, succeeded to his command. After the war he resided in California, and was appointed minister to Mexico in 1868. He rep-

HORACE GREELEY.

resented California in Congress from 1881 to 1885, and later was registrar of the United States Treasury. He was a great general, and is justly entitled to enduring fame.

Commodores.—Horatio Nelson (1758-1805), O. H. Perry (1785-1819), D. D. Porter (1814-1891), G. H. Preble (1816-1885), John Rodgers (1771-1838), John Rodgers (1812-1882), G. W. Rodgers (1787-1832), G. W. Rodgers (1822-1863), C. R. P. Rodgers (1819-1892), J. J. Coffin (1759-1839), Charles Napier (1786-1860), Stephen Decatur (1779-1820), William Bainbridge (1774-1833), John L. Worden (1818), John Paul Jones (1747-1792), Richard Dale (1756-1826), Richard Somers (1778-1804), Edward Preble (1761-1807), Thomas Truxton (1755-1822), James Lawrence (1781-1813), Isaac Hull (1773-1843), Charles Stuart (1778-1869), Thomas Macdonough (1783-1825), S. F. Dupont (1803-1865), Charles Wilkes (1801-1877), A. E. K. Benham (1832-1894), D. G. Farragut (1801-1870), Charles Morris (1784-1856), John A. Dahlgren (1809-1870), George Dewey (1837), W. S. Schley (1839), W. T. Sampson (1840).

Jurists.—Among the great American jurists of the century are John Jay (1745-1829), E. Livingston (1764-1836), Joseph Story (1779-1845), John Marshall (1755-1835), R. B. Taney (1777-1864), James Kent (1763-1847).

The present pope, Leo XIII (Vicenzo Gioachimo Pecci) was born in 1810. He was elected pope February 18, 1878. He is more than any of his predecessors a product of modern times, and the antithesis of his conservative predecessor, Pius, and

HENRY IRVING.

has done much to identify the church with Nineteenth Century progress. He has been a friend of organized labor, for one thing, and has given honor to at least one clergyman who is an avowed believer in the Dar-

theory of development. Leo
ly man, judged by Christian,
n pagan standards of sanctity.
rican Presidents. — All the
nts of the United States
lived during the present
y except one, *pater patriæ*,
in war, first in peace, first in
arts of his countrymen," the
tal Washington. He died on
ry eve of the century, 1799.
successors were: Second,
ent John Adams (1735-1826);
President Thomas Jefferson
826); fourth, President James
on (1751-1836); fifth, President
Monroe (1758-1831); sixth,
ent John Q. Adams (1767-
seventh, President Andrew
n (1767-1845); eighth, Presi-
M. Van Buren (1782-1862);
President W. H. Harrison
841); tenth, President John
(1790-1862); eleventh, Presi-
K. Polk (1795-1849); twelfth,
ent Z. Taylor (1784-1850);
nth, President M. Fillmore
874); fourteenth, President
lin Pierce (1804-1869); fif-
President James Buchanan
868); sixteenth, President
am Lincoln (1809-1865); sev-
th, President Andrew Johnson
875); eighteenth, President
Grant (1822-1885); nineteenth,
ent R. B. Hayes (1822-1893);
eth, President J. A. Garfield
881); twenty-first, President
Arthur (1830-1886); twenty-
l, President Stephen Grover
and (1837); twenty-third,
ent Benjamin Harrison (1833);
-fourth, President Stephen
r Cleveland (1837); twenty-
fifth, President William McKinley
(1843).

A Noble Company.—A magnificent group might be gathered of those who have immortalized their names by noble deeds that have attracted the admiration of mankind. A few representative illustrations may here be given of the growing disposition, never so evident as now, to prove that the

> "Noblest place for man to die,
> Is where he dies for man."

Toussaint l'Ouverture (1743-1803) was a full-blood negro, who rose from the condition of slavery to be a great general and legislator, and the liberator of Hayti. His deeds equaled those of the greatest captains of ancient or modern times. Captured by treachery, he was imprisoned in France, and died a victim to the tyranny of Napoleon. Wendell Phillips pronounced him the greatest man of modern times.

Thaddeus Kosciusko (1746-1817) fought for liberty in America, and in defence of Poland against Russia. Defeated, the Russian emperor offered him his sword, but he declined it, saying, "Since he had no country, he needed no sword." He abolished serfdom in Poland, and entreated the emperor to give Poland a free constitution. The line of Campbell characterizes the hero,

> "Freedom shrieked as Kosciusko fell."

Simon Bolivar (1783-1830), "the Washington of South America," accomplished the independence of three states, and gave to the world an example of lofty heroism and patriotism.

Marco Bozzaris (1790-1823) was the hero of Greece in a nation of heroes, who fell fighting against the Turk, and for his people, who

> "Conquered, though Bozzaris fell,
> Bleeding at every vein."

John Brown (1800-1859), the hero of a forlorn hope, the assailant of slavery, struck almost the first successful blow against "the sum of all villainies." His body was destroyed by his enemies, but "his soul went marching on" to victory.

Louis Kossuth (1802-1894), the eminent Hungarian orator, statesman, hero, was an object-lesson to the nations during a long and heroic life. Though he failed to accomplish the immediate purpose of his struggles, the world was enriched, and mankind ennobled by his splendid example.

Giuseppe Garibaldi (1807-1882), the hero, general, patriot, statesman, who fought for liberty in two continents, was "the most blameless and beloved of men." All lovers of liberty will cherish and honor the name of Garibaldi as one of the grandest in the annals of the valor and patriotism of the century.

These names of a Negro, a Pole, a South American, a Greek, an American, a Hungarian, and an Italian, are typical of thousands possessed by the same spirit that impelled them to duty and to action. They are exponents of the altruistic disposition that is increasing with the growing years, and that is noble not only in war but in peace. For the pilot who will not desert his ship, the engineer who dies at the post of duty, the man or woman in any place who sacrifices self for the welfare of others, manifests the spirit that ennobles the world's truest heroes, and that was shown on the cross—a spirit never so rife as during the "Century of Centuries," the Nineteenth Century.

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